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POLAR CONTINENTAL SHELF PROGRAM

Science Report 07|08

Logistical support for leading-edge scientific research in the Canadian Arctic

Canada

Contact information
Polar Continental Shelf Program
Natural Resources Canada
615 Booth Street, Room 487
Ottawa ON K1A 0E9
Canada
Tel.: 613-947-1650
E-mail: pcsp@nrcan.gc.ca
Web site: polar.nrcan.gc.ca

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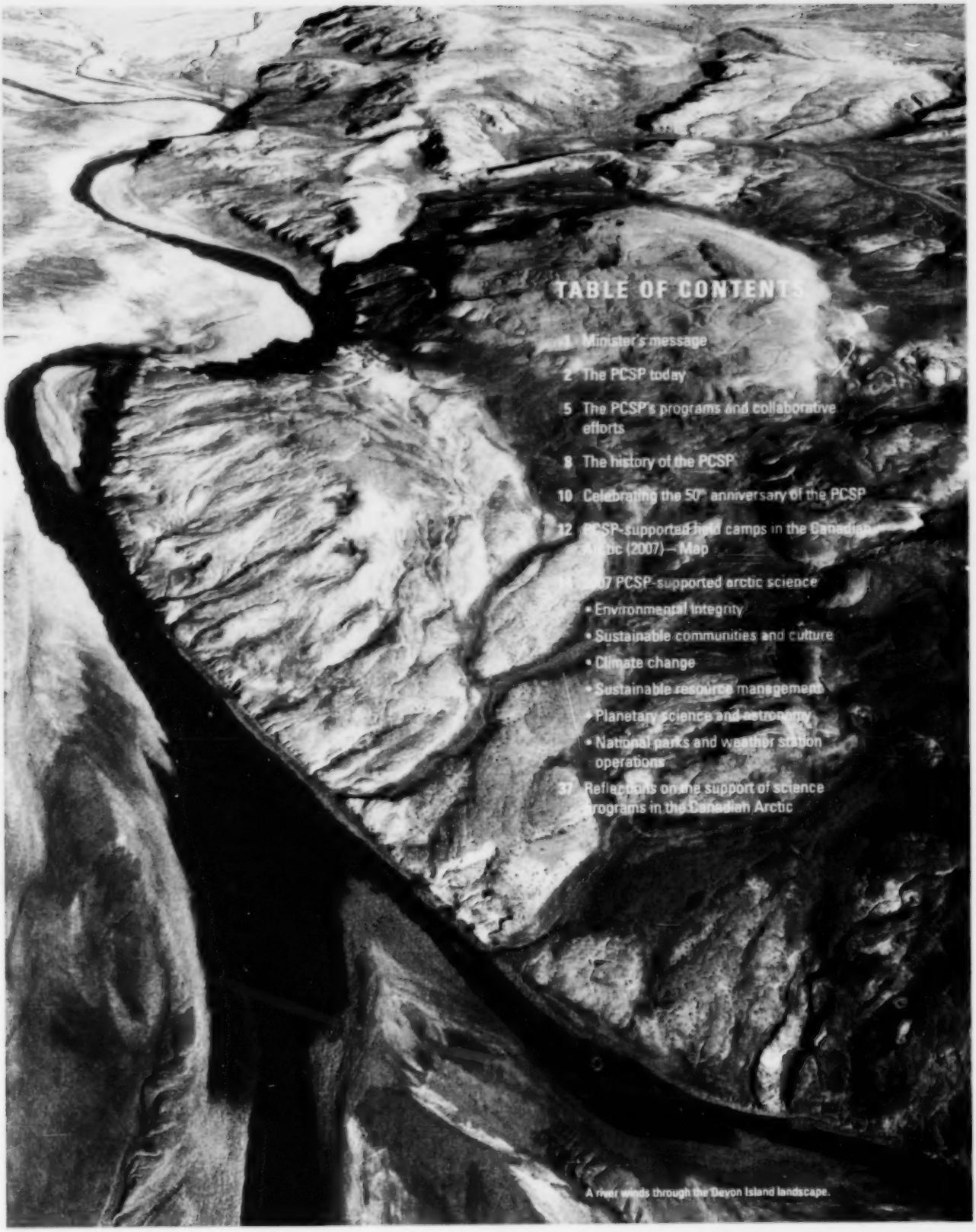

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A river winds through the Devon Island landscape.

MESSAGE FROM THE MINISTER OF NATURAL RESOURCES CANADA

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MESSAGE FROM THE MINISTER OF NATURAL RESOURCES CANADA

It has been an exciting and productive 50 years

for the Polar Continental Shelf Program (PCSP). Beginning as a modest scientific field operation based in Resolute, Nunavut, the PCSP has evolved into a large-scale logistics provider, supporting more than 130 research projects each year at locations throughout the full expanse of Canada's North. The PCSP is a key contributor to our government's Northern Strategy — a new vision for the North founded on sustainable social and economic development, environmental protection, good governance and securing Canada's sovereignty in the far North.

© Courrette/Ottawa

We are just beginning to see the full extent of the enormous potential of Canada's natural resources in the North. There is much to be done, but Canada has the right combination of people, knowledge, expertise and systems to transform this potential into value-added products, new economic opportunities and high-quality jobs. Our government's goal is to reinforce the competitiveness of Canada's natural resources economy while making Canada a world leader in the environmentally responsible development and use of our natural resources.

In the case of the special challenges and unique promises of the North, I'm proud of the PCSP's work in supporting arctic research scientists from across Canada and around the world. From archaeology and northern traditional knowledge to biology, geology and planetary science, the PCSP continues to support a wide range of field research projects. The valuable findings from these studies allow scientists and the public to better understand the Arctic and the environmental, social and economic challenges it faces. In turn, PCSP-supported research, often involving northern residents, is being used to develop plans to address many of the North's challenges.

On the occasion of the PCSP's 50th anniversary, I am especially pleased to make this first annual PCSP Science Report available to you. It features the research findings of a number of PCSP-supported scientists, and it provides detailed information about the PCSP's services and programs, as well as its long and distinguished history. The report also describes the PCSP's close connections to northern communities and organizations, which are critically important elements of its success.

I extend my gratitude to the many scientists, research organizations and northern communities with whom our government has accomplished so much. Together, we have made arctic field research possible, brought national and international attention to our vast northern regions and developed a wealth of knowledge about the Canadian Arctic.

Let us celebrate the PCSP and the accomplishments of its scientists over the past 50 years as we look forward to the innovative research that lies ahead.

Lisa Raitt

The Honourable Lisa Raitt, P.C., M.P.
Minister of Natural Resources

An aerial view of the PCSP Resolute facility.

THE PCSP TODAY

Operations and facilities

The Polar Continental Shelf Program (PCSP) (previously called the Polar Continental Shelf Project) is an organization within Natural Resources Canada (NRCan) that provides cost-effective logistics and support services to field research projects throughout the Canadian Arctic.

The research conducted by these scientists is diverse, ranging from archaeology to zoology. In 2007, the PCSP supported 123 projects led by scientists from Canadian universities, federal government departments, territorial government departments, independent groups and foreign agencies. The research community applies annually to the PCSP for support during the following field season.

The PCSP provides the following services:

- air transportation to and from field camps throughout the Canadian Arctic
- accommodation and meals when staying at the PCSP Resolute and Environment Canada Eureka facilities
- a radio and satellite telephone communications network
- navigation and global positioning systems
- field equipment (e.g. tents and snowmobiles)
- fuel for aircraft, equipment and field camps
- workspace at the PCSP Resolute facility

The PCSP's primary service is highly organized and efficient return transport for researchers to and from remote field camps by small airplane (fixed-wing aircraft) and helicopter (rotary-wing aircraft). Logistical support is primarily based out of the PCSP's facility at Resolute, Nunavut, but aircraft operations are also coordinated out of Inuvik, Northwest Territories, for field camps in western arctic areas.

The PCSP Resolute facility serves as a staging area for research conducted in virtually any location in the Canadian Arctic. The Hamlet of Resolute, located on Cornwallis Island (74°43' N, 94°59' W), is a mostly Inuit community of about 230 people. The PCSP base at Resolute is composed of two main buildings and is located at the edge of the airport, about 7 km from the settlement. A small team of PCSP staff manages the operations at the base and plays an integral role in the lives of field researchers during their field seasons.

The PCSP residence building has sleeping areas for 41 clients, a kitchen and dining area, recreation rooms and staff quarters. The working facility houses the base office, equipment storage areas, workrooms and a helicopter maintenance shop. The work building is the main equipment preparation and organization site for researchers heading out to field camps, and it is where some equipment maintenance and repair can be done.

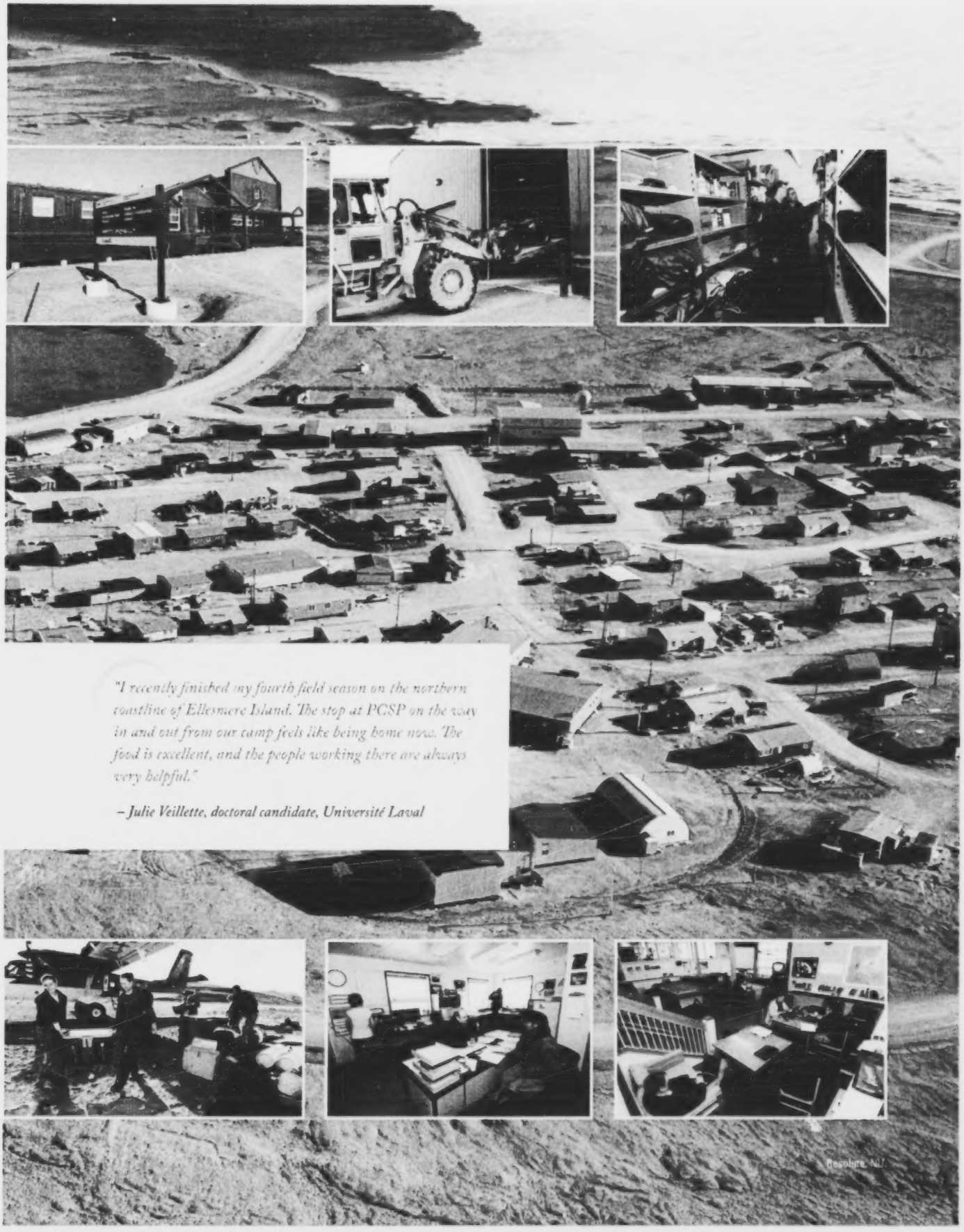
Most researchers spend only a short time at the PCSP base each field season, just before and after working in remote field camps. After weeks to months of camp life, researchers get to enjoy modern amenities at the Resolute facilities.

"I'm always in awe of how a warehouse full of quads, snow machines and tents can be managed so effectively by such a small number of people. A first evening in PCSP typically consists of an eagerly anticipated meal, a chat with colleagues in the kitchen, followed by a walk to the warehouse to find our requested gear waiting on a pallet, ready to be loaded the next morning."

- Ted Lewis, post-doctoral fellow, Queen's University

Field equipment support services

Field researchers can apply for equipment loans from the inventory at the PCSP's Resolute facility and through PCSP's Technical Field Support Services (TFSS), based in Ottawa, Ontario (Web site: ess.nrcan.gc.ca/tfss-sstt/index_e.php). TFSS was established in 1930 by the Geological Survey of Canada and recently became part of the PCSP. Through TFSS, PCSP-supported researchers have access to field equipment based on a fee-for-service delivery model. The equipment inventory ranges from camping equipment and field vehicles (e.g. snowmobiles and boats) to clothing and communications and safety equipment.



"I recently finished my fourth field season on the northern coastline of Ellesmere Island. The stop at PCSP on the way in and out from our camp feels like being home now. The food is excellent, and the people working there are always very helpful."

– Julie Veillette, doctoral candidate, Université Laval

PCSP employees George Benoit and Wally Benoite at the workshop in Resolute.

The PCSP supported researchers from the following organizations in 2007:

Canadian universities and related organizations

University of Alberta
University of British Columbia
University of Calgary
Carleton University
Dalhousie University
University of Guelph
Institut national de la recherche scientifique
Lakehead University
Laurentian University
Université Laval
University of Manitoba
McGill University
Memorial University of Newfoundland
University of Ottawa
Université du Québec à Montréal
Université du Québec à Rimouski
Queen's University
Simon Fraser University
University of Toronto
Trent University
University of Victoria
University of Waterloo
Wilfrid Laurier University
York University

Federal government organizations

Canadian Museum of Civilization
Canadian Museum of Nature
Canadian Space Agency
Environment Canada
Fisheries and Oceans Canada
Indian and Northern Affairs Canada
National Research Council
Natural Resources Canada
Parks Canada

Other government organizations

Government of the Northwest Territories
Government of Nunavut
Government of Yukon
Vuntut Gwitchin Government

Independent organization

Ilisaqsivik Society

Foreign organizations and universities

Icelandic Institute of Natural History (Iceland)
MARS Institute (United States)
NASA Ames Research Center (United States)
National Parks & Wildlife Service of Ireland
U.S. Geological Survey
University of Exeter (United Kingdom)
University of Minnesota (United States)
Wildfowl and Wetlands Trust (United Kingdom)

PCSP facts for the 2007 field season

Value of support provided	$7,971,500
Projects supported	123
Participants in field activities	1135
Flight hours – Twin Otter aircraft	1726
Flight hours – helicopter	3783
Accommodation nights provided at the PCSP Resolute facility	1370
Meals provided at the PCSP Resolute facility	>4000
All-terrain vehicles supplied	38
Cans of bear spray supplied	32
Satellite telephones supplied	70
Snowmobiles supplied	29
Tents supplied	164

THE PCSP'S PROGRAMS AND COLLABORATIVE EFFORTS

The PCSP's programs

Traditional Knowledge Program

Traditional Knowledge is "a cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment."[1] Many northern Aboriginal communities have placed renewed importance and urgency on the continued transfer of Traditional Knowledge, because it is crucial for today's young people and future generations to develop their understanding of their culture and surrounding environment and to help plan their future.

To contribute to the preservation of this invaluable repository of knowledge, the Polar Continental Shelf Program (PCSP) established the Traditional Knowledge Program. The program provides logistical support customized for Traditional Knowledge research conducted by, or in collaboration with, northern communities. The PCSP has supported 51 projects through this program since it began in 1994.

The Canadian Arctic–Antarctic Exchange Program

The Canadian Arctic–Antarctic Exchange Program was established in 1996 to encourage collaboration among Canadian scientists working in the Arctic and foreign scientists who work primarily in the Antarctic. For approved projects, the foreign collaborators are eligible for the same type of PCSP logistical support that Canadian scientists receive in the Canadian Arctic. In return, logistical support is expected for Canadian scientists during their Antarctic field work. Nineteen projects have been undertaken in this program to date.

SPOTLIGHT

Brenda Eckalook – Resolute resident working with the PCSP

The PCSP's operations and the scientific research it supports in the Canadian Arctic often provide employment opportunities for members of predominantly Aboriginal communities. These opportunities range from working as part of a research team in a field camp to assisting with office activities. This work provides direct economic benefits for northern communities, strengthens connections between field studies and those communities and allows researchers to learn from the experience and knowledge of northern residents.

Brenda Eckalook loves living in Resolute, Nunavut, and "being able to hop on an all-terrain vehicle or a snow machine and enjoy what nature has to offer." During 2008, Brenda worked as an office assistant at the PCSP staging facility. Her job included many activities that were key to daily field operations, including monitoring flights going to and from remote field camps; assisting with communications between the PCSP base, aircraft and camps; and managing files.

Brenda also organized a successful 50th Anniversary Open House at the PCSP facility in July. She refers to that event as her most memorable experience while working with the PCSP. She undertook a major community outreach effort to inform the residents of Resolute about the event and invite them to participate. Brenda also arranged for performances by Inuit throat singers and dancers and for translators to be available for community members requiring them. The event brought together community members, PCSP-supported scientists and invited guests to discuss northern science and learn from each other. Through her position with the PCSP, Brenda particularly enjoyed learning about the types of research going on in the region. She was an important part of the PCSP team in 2008 and helped ensure the success of PCSP operations throughout the field season.

[1] Berkes, F., Colding, J., and Folke, C. 2000. Rediscovery of Traditional Ecological Knowledge as adaptive management. *Ecological Applications*, 10: 1251–1262.

IPY Project: *Measuring the Impact of Climate Change on Landscape and Water Systems in the High Arctic.* Scott Lamoureux and [illegible] (Queen's University) examine flow rates in a tributary at the Cape Bounty Arctic Watershed Observatory on Melville Island.

The PCSP's collaborations

Northern communities and organizations

All scientific research conducted in northern Canada must be approved by appropriate licensing organizations and communities to ensure that cultural considerations are addressed, environmental regulations are followed and the results of the studies (once available) are made available to northern residents. The PCSP works closely with the territorial scientific licence issuers, including Nunavut Research Institute (Iqaluit, Nunavut), Aurora Research Institute (Inuvik, N.W.T.) and the Government of Yukon Territory (Department of Tourism and Culture, Whitehorse, Y.T.), to ensure full understanding of licensing requirements for PCSP-supported research.

Debbie Iqaluk holds an Arctic Char caught at Char Lake, near Resolute, NU. Debbie's surname means "Char" in Inuktitut.

The PCSP values its relationships with northern communities and works to develop significant community engagement wherever possible. The PCSP works with northern businesses, including many businesses owned and operated by Aboriginal people and organizations, and employs local residents, thereby contributing directly to the northern economy. Additionally, many PCSP-supported researchers hire residents of northern communities as research assistants and safety monitors in their field camps, where these local experts can share their knowledge of the arctic environment. PCSP-supported scientists also often visit northern schools and community centres to share their research with youth and their communities.

International Polar Year

International Polar Year (IPY) is a major international science program taking place from March 2007 to March 2009. It focuses on Arctic and Antarctic natural and social sciences and involves researchers from more than 60 countries (Canadian government IPY Web site: ipy-api.gc.ca, Canadian IPY Committee Web site: www.ipycanada.ca, International IPY Web site: ipy.org).

Research activities supported through federal IPY funds relate to two priority areas: science for climate change impacts and adaptation, and the health and well-being of northern communities. The results of IPY research will become available over the next few years and contribute substantially to our knowledge of the changing Arctic. The PCSP supported 25 IPY projects in 2007 that covered a diverse range of research fields, including studies on Traditional Knowledge, wildlife habitat and behaviour, tundra ecosystems, archaeology, hydrology, sea ice, glaciology and climate change processes.

ITEX (International Tundra Experiment) and IPY Project: *Climate Change Impacts on Canadian Arctic Tundra*. Greg Henry and Adrian Leitch (University of British Columbia) examine the effects of experimental warming of tundra plants at Alexandria Fiord, Ellesmere Island.

Federal granting agencies

While the PCSP provides logistical support for scientists, many university researchers have research grants from Canada's federal granting councils to support their research programs. The PCSP is working closely with the Natural Sciences and Engineering Research Council of Canada, the Social Sciences and Humanities Research Council of Canada and the Canadian Institutes of Health Research to develop synergies that will result in improved efficiency in the delivery of support to arctic scientists.

Forum of Arctic Research Operators

The PCSP is Canada's national representative in the international Forum of Arctic Research Operators (FARO). FARO organizes and optimizes the provision of logistical support in the circumpolar Arctic by facilitating collaboration among 17 countries with arctic research interests (Web site: www.faro-arctic.org).

THE HISTORY OF THE PCSP

The origins of the PCSP

The Government of Canada officially created the Polar Continental Shelf Program (PCSP) in spring 1958 in response to the need for information on Canada's arctic continental shelf area. Interest and activity in Canada's North had been developing for years, including the construction of five joint Canada–United States arctic weather stations during the late 1940s and a set of radar stations (the Distant Early Warning Line) across the region during the mid-1950s. Demands for scientific knowledge of the Canadian Arctic increased after Canada's resource and exploration rights were extended to the continental shelf in the late-1950s. At the same time, other countries needed geophysical information about the largely unstudied arctic region for their space programs.

Denis St-Onge operates an amphibious vehicle ("The Rat") at Isachsen, Ellef Ringnes Island.

GSC (1959)

The fundamental ideas for PCSP operations were developed by Fred Roots, Jim Harrison and Hugh Bostock when they were working with the Geological Survey of Canada. One day in September 1958, they were having lunch on a boulder near the terminus of the Chutine Glacier in the Coast Mountains of British Columbia. They were discussing future directions for research in remote areas, after having successfully completed major programs in the North. These studies had shown the feasibility and efficiency of integrating field operations involving numerous scientists and interdisciplinary research in remote areas where logistical costs were high. With increasing focus on northern resources, the group discussed the importance of Canada's ensuring proper jurisdiction over mineral resources in the country's continental shelves.

Jim Harrison said that they should plan a Canadian-controlled operation, separate from the International Geophysical Year occurring at the time, to survey the arctic continental shelf. The Canadian program would ensure that the country had a strong position for responding to discussions of the Law of the Sea under the United Nations. The ideas discussed that day formed the basis for the work that was conducted by the PCSP in the following few years and, indeed, up to the present day.

In the fall of 1958, Fred Roots was named PCSP's first Director, and planning began for the first PCSP field season in 1959. The mandate of the organization was to provide researchers with efficient and safe logistical support and to strengthen sovereignty in the North. With the establishment of the PCSP, scientists from a number of federal departments worked under the umbrella of the PCSP to study the arctic continental shelf.

The early PCSP field seasons

The first few field seasons for the PCSP focused on determining the logistical requirements for supporting arctic field work, addressing issues of navigation for field parties and collecting data on the geology, geophysical properties and oceanographic conditions of different locations along the arctic continental shelf.

"It was a very exciting time for a young scientist to be working in the High Arctic."

- Denis St-Onge, Geological Survey of Canada and one of the PCSP's first researchers

Denis St-Onge on Ellef Ringnes Island.

PCSP (1959)

Directors of PCSP (1958–2008)	
Fred Roots	1958 to 1971
George Hobson	1972 to 1988
Pierre Lapointe	1988
Bonni Hrycyk	1989 to 2007
Marty Bergmann	2007 to present

Surveying completed through early PCSP studies corrected the placement of Meighen Island on maps. Previously, this island had been drawn several kilometres away from its true location. By 1960, 14 parties of scientists were working out of Isachsen, the joint Canada–United States weather station on Ellef Ringnes Island.

The establishment of a navigation system and detailed surveying work conducted during these years were instrumental in paving the way for future work in the region. Similar PCSP research continued along the arctic continental shelf during the 1960s, and two studies were conducted at the North Pole. The PCSP facilities were expanded to provide the required increase in the range of operations.

The further evolution of the PCSP

As the PCSP developed, its areas of research expanded beyond its initial focus on geology, geophysics and oceanography. By the 1970s, studies of wildlife, vegetation and archaeology were increasing in number.

In 1972, George Hobson became the second Director of the PCSP, and one of his first priorities was to ensure that Northerners were aware of the research being undertaken in their region. Beginning in 1972, George made regular visits to northern communities to discuss the PCSP science to be conducted in the upcoming field season, to gain insight into what science was of interest to the communities and to take note of community requests for information.

"When I became Director of PCSP, I soon saw the opportunity, indeed the obligation, to make regular contact with arctic communities through the local council or the Hunters and Trappers Organization and to keep northern residents aware of scientific projects in their areas of concern – their backyards. Communication between scientists and northern residents is essential."

- George Hobson

Major projects conducted by PCSP researchers during the 1970s and early 1980s include the international Arctic Ice Dynamics Joint Experiment, the Lomonosov Ridge Experiment and the Canadian Expedition to Study the Alpha Ridge. These last two projects studied the properties of the Lomonosov and Alpha Ridges, which are underwater mountain ranges that extend north from Canada's arctic continental shelf. The projects involved organizing logistics for, and conducting field work based out of, sea ice camps located as far north as the North Pole.

In 1982, a large piece of ice calved from the Ward Hunt Island Ice Shelf of northern Ellesmere Island. In 1983, the PCSP began developing the Ice Island Scientific Research Station on the approximately 40 m-thick, 13 km-long and 5 km-wide slab of ice. The ice island was dubbed "Hobson's Choice," which referred to the expression used when one chooses the only option available or nothing at all. It was also fitting that the PCSP's Director at the time shared his name with the expression. Scientific studies on the ice island included magnetic and gravity measurements and seismic research to study rock structure beneath the ocean floor. The intent was for operations to continue at the camp over decades as the ice island floated around the Arctic Ocean. Unfortunately, during the winter of 1990, it was blown east and subsequently broke up between the islands of the Arctic Archipelago. However, much scientific knowledge was developed through studies on the floating scientific laboratory during the years that it operated.

The range of research being conducted by the PCSP's scientists broadened over time, and the PCSP witnessed a major increase in the number of university-led research projects requesting funding. In 1986, the PCSP changed from having its own researchers to focusing on providing logistical support to researchers from universities, government and non-governmental organizations. By extending support to outside groups, the range of science conducted in the Canadian Arctic became progressively broad and today encompasses a wide spectrum of topics in the social and natural sciences.

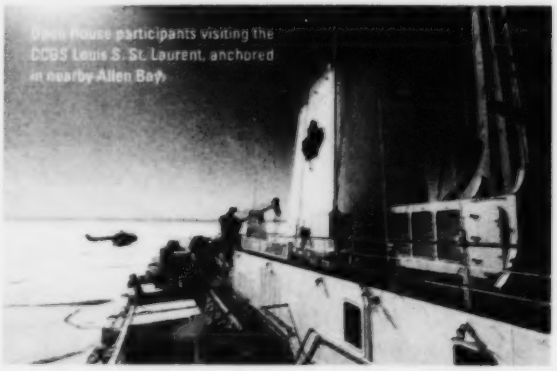
Pierre Lapointe was Director of the PCSP in 1988, after which Bonni Hrycyk became Director and remained in this position until 2007. During her time as Director, the PCSP Traditional Knowledge Program was established. This program has provided opportunities for communities, northern organizations and researchers to study topics of particular interest to northern communities. The Canadian Arctic–Antarctic Exchange Program was also established during the 1990s and has allowed PCSP-supported researchers to extend their studies to cover both polar regions. The PCSP is currently celebrating 50 years of providing support to arctic researchers, with Marty Bergmann as Director.

50 *Years • Ans*

Polar Continental Shelf Project
Étude du plateau continental polaire

CELEBRATING THE 50TH ANNIVERSARY OF THE PCSP

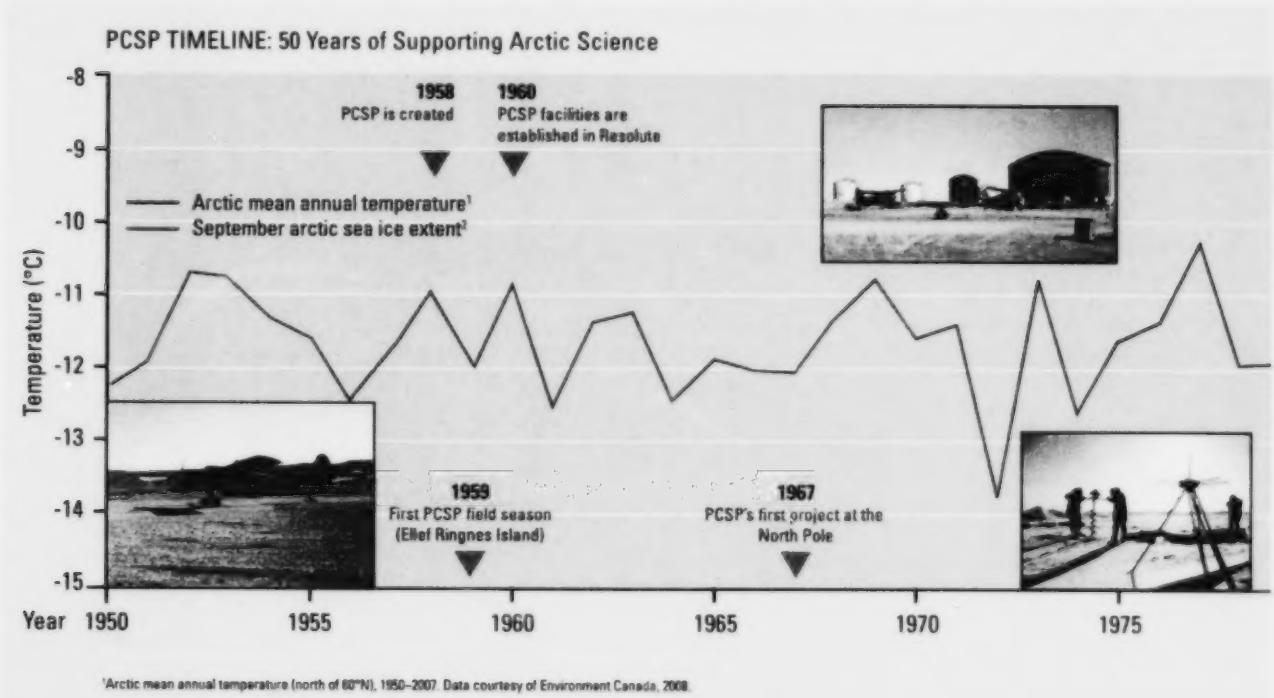
Workshop panelists Dan Lemmen (Natural Resources Canada), Louis Fortier (University Laval), David Barber (Natural Resources Canada), Andrew Applegate (Aurora Research Institute), Scot Nickels (Inuit Tapiriit Kanatami) and Sonia Ostertag (University of Northern British Columbia)



Open House participants visiting the CCGS Louis S. St. Laurent, anchored in nearby Allen Bay.

On May 14, 2008, government officials, Aboriginal community representatives, former directors of the Polar Continental Shelf Program (PCSP), university and government researchers, and students attended the PCSP's 50th Anniversary celebrations held at, and in partnership with, the Canadian Museum of Civilization in Gatineau, Quebec.

Fred Roots, George Hobson and Pierre Lapointe attended, and past and present PCSP personnel and researchers gave presentations during the science workshop. Topics discussed included the early days and evolution of the PCSP, current PCSP-supported arctic research and future plans and anticipated initiatives related to arctic science. Additionally, an expert panel was assembled to foster discussions about



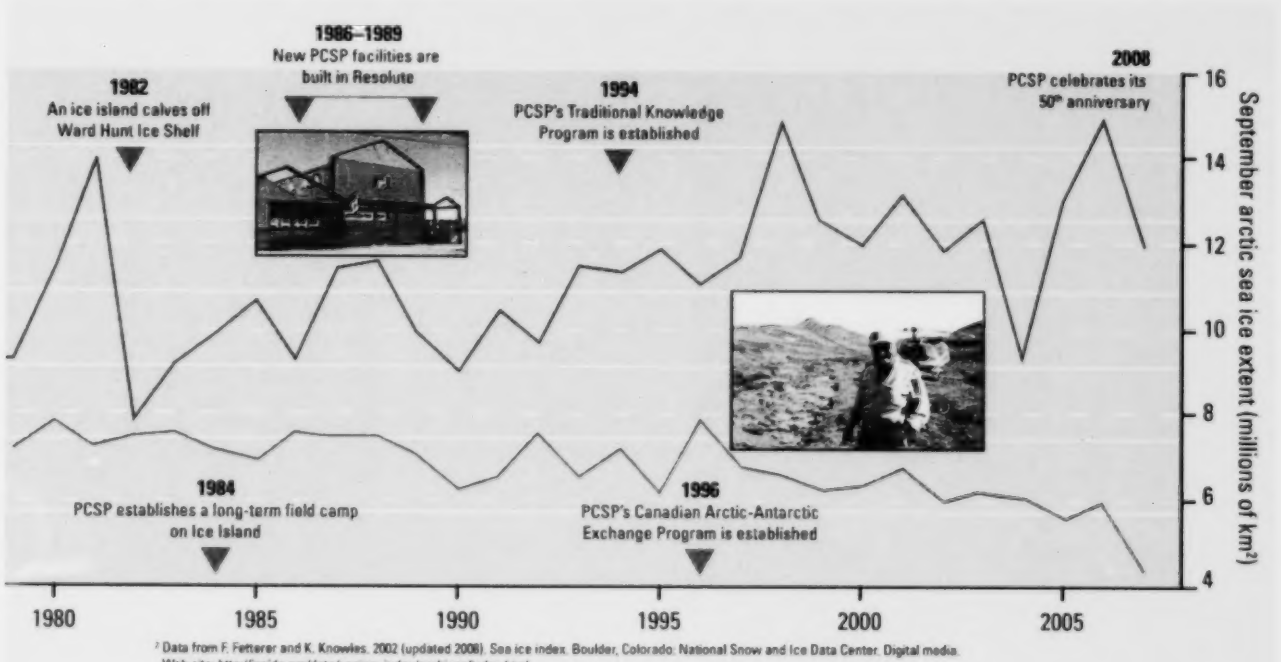
[1]Arctic mean annual temperature (north of 60°N), 1950–2007. Data courtesy of Environment Canada, 2008.

Traditional Inuit dancing by local youth.

how to use arctic science to address the needs of Northerners and how to include northern communities in research activities. The day was a success and promoted much discussion and interaction among the many groups involved with arctic research.

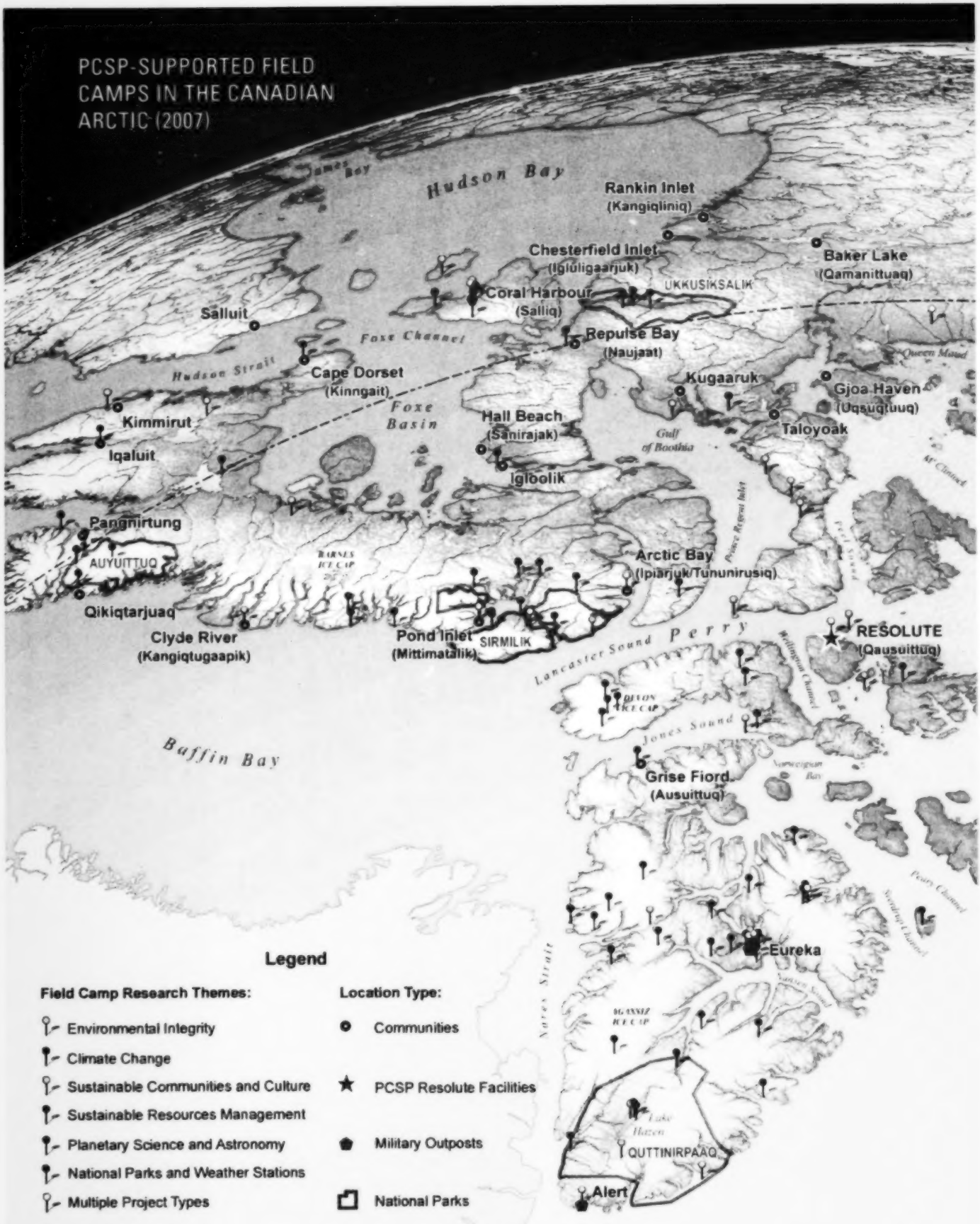
On July 12, 2008, an Open House was held at the PCSP base in Resolute. This event provided an opportunity for residents of Resolute and invited guests to visit and tour the PCSP facilities and to learn about scientific research being conducted through a series of presentations. Also, the Canadian Coast Guard icebreaker CCGS Louis S. St-Laurent was anchored in the adjacent Allen Bay, and it welcomed community members and invited guests for a tour of the ship.

The Open House provided a wonderful opportunity for the PCSP to engage the local community in PCSP's operations and the science it supports. Along with government officials and visitors from media, business and political groups, more than 100 Resolute residents enjoyed seeing and learning about PCSP's facilities, operations and supported science.



[1] Data from F. Fetterer and K. Knowles. 2002 (updated 2008). Sea ice index. Boulder, Colorado: National Snow and Ice Data Center. Digital media. Web site: http://inside.org/data/seaice_index/archives/index.html.

Photo credits (left to right): Denis St-Onge (first two images), Natural Resources Canada (photo F92SO217B), Roxanne Lodge and Shirleen Smith.


PCSP-SUPPORTED FIELD CAMPS IN THE CANADIAN ARCTIC (2007)
Hudson Bay
James Bay
Rankin Inlet (Kangiqliniq)
Chesterfield Inlet (Igluligaarjuk)
Baker Lake (Qamanittuaq)
Coral Harbour (Salliq)
UKKUSIKSALIK
Salluit
Foxe Channel
Repulse Bay (Naujaat)
Queen Maud
Hudson Strait
Cape Dorset (Kinngait)
Kugaaruk
Gjoa Haven (Uqsuqtuuq)
Foxe Basin
Kimmirut
Hall Beach (Sanirajak)
Taloyoak
Gulf of Boothia
Iqaluit
Igloolik
Pangnirtung
AUYUITTUQ
BARNES ICE CAP
Arctic Bay (Ipiarjuk/Tununirusiq)
Prince Regent Inlet
Qikiqtarjuaq
Clyde River (Kangiqtugaapik)
Pond Inlet (Mittimatalik)
SIRMILIK
Lancaster Sound
Perry
RESOLUTE (Qausuittuq)
DEVON ICE CAP
Jones Sound
Wellington Channel
Baffin Bay
Grise Fiord (Ausuittuq)
Eureka
Nares Strait
Lake Hazen
QUTTINIRPAAQ
Alert
Legend
Field Camp Research Themes:
Environmental Integrity
Climate Change
Sustainable Communities and Culture
Sustainable Resources Management
Planetary Science and Astronomy
National Parks and Weather Stations
Multiple Project Types
Location Type:
Communities
PCSP Resolute Facilities
Military Outposts
National Parks

Air Distances in Kilometres

					Yellowknife	Whitehorse
				Iqaluit	2260	3305
			Alert	2091	2626	3103
		Eureka	480	1884	2145	2652
	Inuvik	1843	2274	2843	1103	852
Resolute	1503	623	1090	1573	1560	2222

Air distances and directions follow great circle routes: the shortest distance between places on the globe and the route most often taken by aircraft.

Community names derived from the Canadian Geographical Names Data Base and Furgal, C., Kalhok, S., Loring, E. and Smith, S. 2003. *Knowledge in action: northern contaminants program structures, processes and products.* Indian and Northern Affairs Canada, Canadian Arctic Contaminants Assessment Report II, 90 pp.

Vertical Near Side Perspective Projection, height adjusted to 3000 km above the Earth

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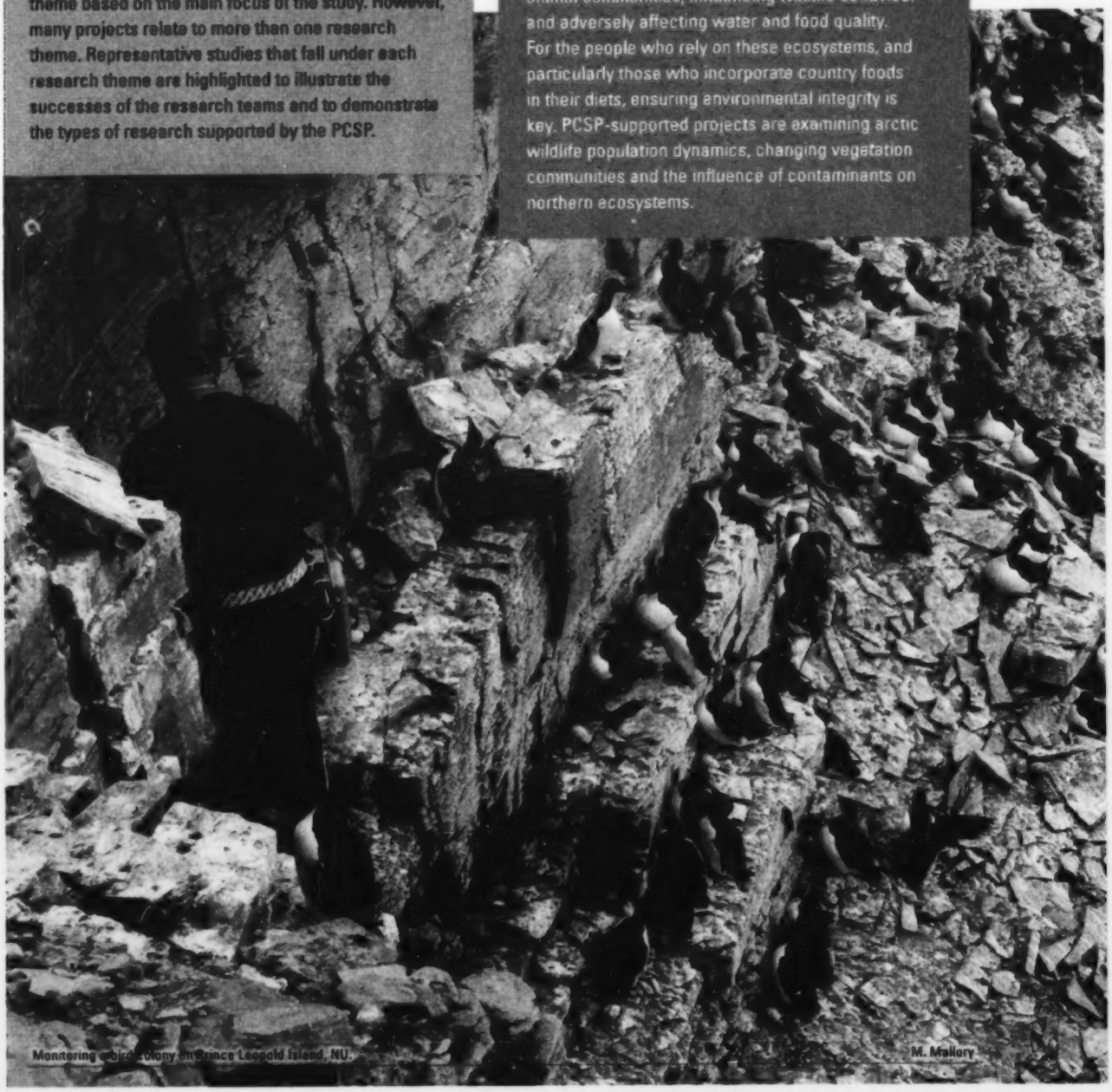
2007 PCSP-SUPPORTED ARCTIC SCIENCE

The Polar Continental Shelf Program (PCSP) supported 123 projects in a wide range of disciplines in 2007, including many studies led by researchers who are world leaders in their fields. To highlight in this report the significance of this work to major areas of scientific and societal interest in the Canadian Arctic, each project is placed in a broad research theme based on the main focus of the study. However, many projects relate to more than one research theme. Representative studies that fall under each research theme are highlighted to illustrate the successes of the research teams and to demonstrate the types of research supported by the PCSP.

ENVIRONMENTAL INTEGRITY

Ecosystems are made up of many interconnected components. If one component is disturbed, the effects are felt in other parts of the ecosystem. Arctic ecosystems are under stress from several factors, including climate change and the impacts of contaminants that are often derived from industrial activities in more southern areas of North America and Asia. These stresses are altering plant and animal communities, influencing wildlife behaviour and adversely affecting water and food quality. For the people who rely on these ecosystems, and particularly those who incorporate country foods in their diets, ensuring environmental integrity is key. PCSP-supported projects are examining arctic wildlife population dynamics, changing vegetation communities and the influence of contaminants on northern ecosystems.



Monitoring colony on Prince Leopold Island, NU. M. Mallory

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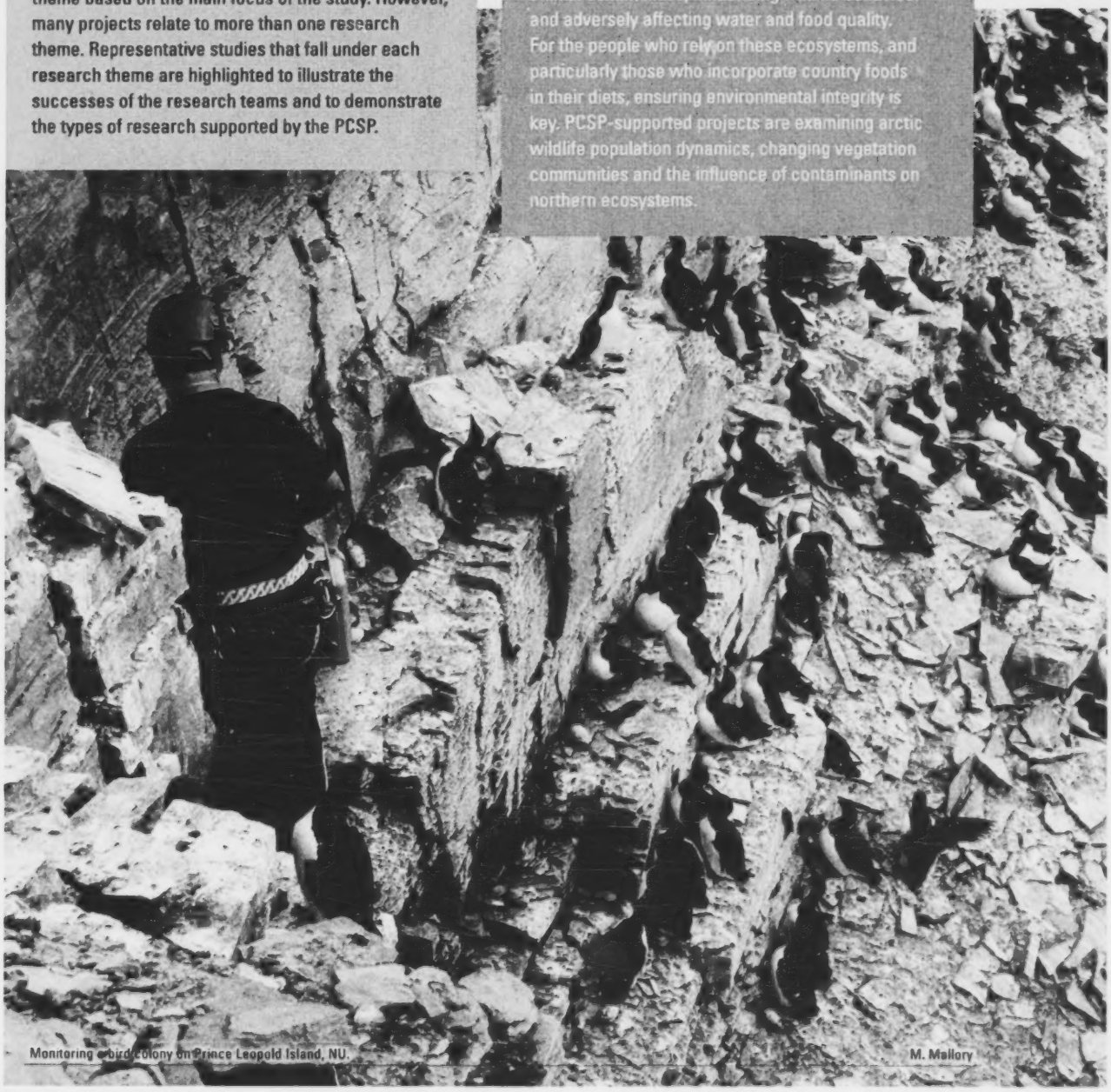
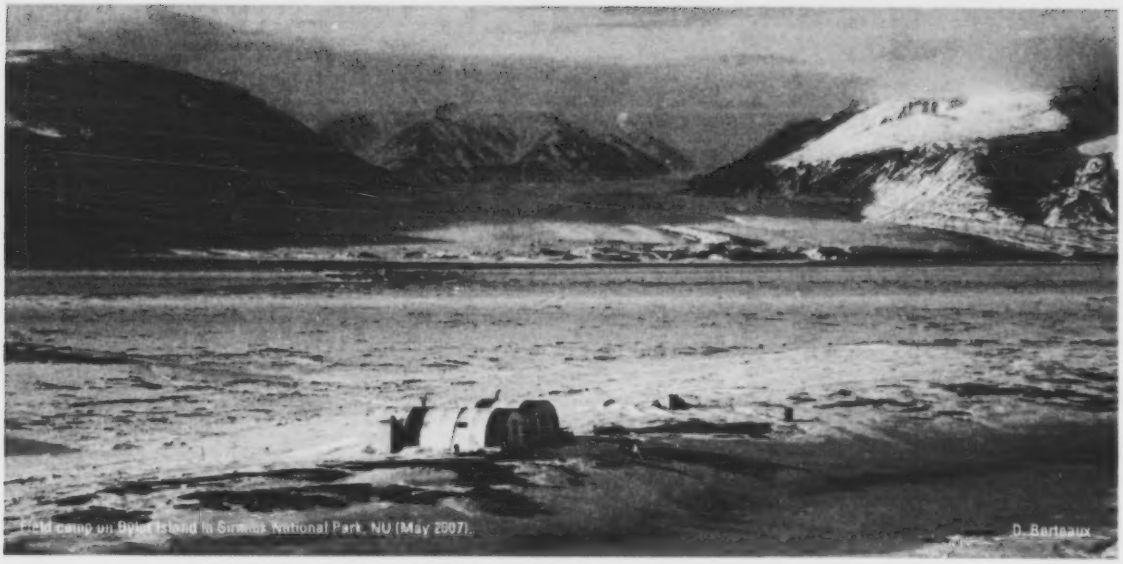


Monitoring a bird colony on Prince Leopold Island, NU. M. Mallory



Field camp on Bylot Island in Sirmilik National Park, NU (May 2007). D. Berteaux

Ecology of arctic and red foxes at Bylot Island

Principal investigators: Dominique Berteaux (Université du Québec à Rimouski) and Jean-François Giroux (Université du Québec à Montréal)

The arctic fox is the primary predator in the tundra ecosystem of Bylot Island in Sirmilik National Park, Nunavut. The red fox has recently moved northward into arctic fox territory, possibly as a result of recent climate warming. Although the red fox population remains low on Bylot Island, effects on the arctic fox population have already been seen. Some arctic fox dens are not occupied anymore, and red foxes are preying on and competing with arctic foxes.

Since 2003, Dominique Berteaux and colleagues have been examining the fox population in Sirmilik National Park to understand the relationships between arctic and red foxes and between the foxes and their prey. In 2007, the field team monitored 99 arctic fox dens, observing 10 arctic fox litters (3 to 12 cubs each) but no red foxes. They captured, tagged and took hair and blood samples for genetic analysis from 22 adult and 50 juvenile arctic foxes.

Laboratory analyses demonstrated cases of multiple paternity, which was a surprising result because arctic foxes were previously thought to be monogamous. These findings provide important information for evaluating and understanding the genetic diversity of the arctic fox population, and genetic testing will continue to improve understanding of the causes of the observed patterns.

Arctic fox on Bylot Island, NU (May 2007). D. Berteaux

Satellite tracking collars show that the average summer territory for the adult foxes studied was about 23 km^2. After ice formed on adjacent Navy Board Inlet, the foxes made extensive use of the sea ice, substantially increasing the size of their home ranges. However, the extent of this behaviour has not been fully quantified yet. This ongoing study will examine if such factors as lemming availability, sea ice conditions or weather influence how foxes use sea ice.

The study also incorporates Traditional Knowledge from residents of nearby Pond Inlet. In 2006, community members provided information on fox-trapping techniques, fox den locations outside the study area and fox winter ecology. This knowledge was used to test new trapping methods, and it will also be used to interpret results from winter satellite tracking.

Research findings have been presented to the community of Pond Inlet during workshops and school presentations. Biodiversity changes in the Arctic is one of many topics discussed by Dominique Berteaux as a major contributor to the 2007 book *Perdre le Nord?* (Boréal-Névé editions). The book won the prestigious Science and Society Book Award from the Canadian Science Writers' Association.

"Through this research, we are monitoring the ecological integrity of Canada's national parks, identifying how climate change and other disturbances affect arctic wildlife and gaining a better understanding of the ecological functioning of tundra ecosystems."

- Dominique Berteaux

Kelly Boadway and Josh Boadway observe and count Arctic Terns and other birds near their blind on "Tern Island," located in Queen's Channel, NU.

Arctic bird population health and ecology

Principal investigator: Mark Mallory (Canadian Wildlife Service, Environment Canada)

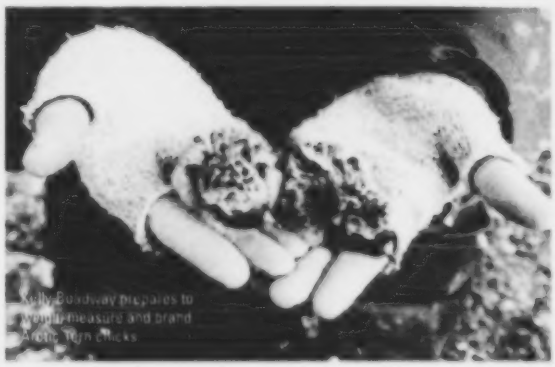
Many arctic bird species are being monitored to assess population health and response to habitat changes. In 2007, Mark Mallory and colleagues from Environment Canada and universities undertook a number of studies on avian population dynamics and health at arctic bird colonies:

- One study in Penny Strait, Nunavut, is focused on Ross's gulls, a threatened species in Canada. The research team found that the birds nested earlier than other arctic ground-nesting marine birds and appeared more easily disturbed by motion near their nests. Results of this ongoing work will be used to develop a recovery plan for this species. Other birds in the area, including arctic terns, common eiders, long-tailed ducks and Sabine's gulls, were also studied to examine breeding success, avian health and contaminants levels and to test for the presence of avian influenza.
- A second study that focused on ivory gulls found significant declines in the Canadian population. This finding resulted in their designation as an endangered species and increased international interest in further examining circumpolar ivory gull populations.
- A third study of fulmars at Cape Vera, Devon Island, Nunavut, documented different breeding behaviour than that of fulmars in the North Atlantic region. Results also showed that the birds were adversely affected by garbage in Baffin Bay. This collaborative research also showed that fulmars carry contaminants within their bodies to the Cape Vera cliffs, where they are deposited in the ponds below, negatively affecting water quality.

This series of studies includes Traditional Knowledge, with assistance from the communities of Resolute Bay, Arctic Bay and Pond Inlet. The research team has worked with residents of these communities to learn about changing ice conditions and whether changes in the number of birds or the timing of their arrival in nesting areas coincide with ice changes over time. Project results are disseminated annually to Nunavut communities in a translated summary document called *Coastlines*.

"Our work aims to determine if stressors such as climate change and contaminants affect the birds and, if so, how the birds compensate for these changes, if they can."

- Mark Mallory



Kelly Boadway prepares to weigh, measure and brand Arctic Tern chicks

Projects focused on environmental integrity issues

Ecology of arctic and red foxes at Bylot Island: influences of food resources and climate on the functioning of a predator community of the arctic tundra

Location: Bylot Island, NU

Principal investigators and affiliations: Dominique Berteaux (Département de Biologie, Université du Québec à Rimouski) and Jean-François Giroux (Université du Québec à Montréal)

E-mail: dominique_berteaux@uqar.qc.ca

Web site: www.cen.ulaval.ca/bylot/index.html

Fishing branch hydrogeology and karst

Location: Fishing Branch River at Bear Cave Mountain, northern Yukon Territory

Principal investigators and affiliations: Ian Clark, Bernard Lauriol, Nicholas Utting and Angelina Buchar (Department of Earth Sciences, University of Ottawa)

E-mail: idclark@uottawa.ca

Web site: www.science.uottawa.ca/~clark/clark.html

Lougheed Island research site inspection

Location: Lougheed Island, NU

Principal investigator and affiliation: Mark Dahl (Environmental Protection Branch, Environment Canada)

E-mail: mark.dahl@ec.gc.ca

Investigating potential regional effects of climate warming on mercury concentrations in landlocked arctic char (Salvelinus alpinus)

Locations: Resolute, Cornwallis Island, and Lake Hazen, Ellesmere Island, NU

Principal investigator and affiliation: Klaus Gantner (Department of Environmental Biology, University of Guelph)

E-mail: ngantner@uoguelph.ca

Arctic Shorebird Monitoring Program

Locations: Eureka and Alert, Ellesmere Island, Axel Heiberg Island, Melville Island, NU, and Prince Patrick Island, N.W.T.

Principal investigator and affiliation: Vicky Johnston (Canadian Wildlife Service – Yellowknife, Environment Canada)

E-mail: vicky.johnston@ec.gc.ca

Bryophytes as bioindicators of anthropogenic and natural environmental change in Arctic Canada

Locations: Lake Hazen and Svendrup Pass, Ellesmere Island, NU

Principal investigator and affiliation: Catherine La Farge (Department of Biological Sciences, University of Alberta)

E-mail: clafarge@ualberta.ca

Population studies of arctic seabirds at Coats Island, Nunavut

Location: Coats Island, NU

Principal investigator and affiliation: Mark Mallory (Canadian Wildlife Service, Environment Canada)

E-mail: mark.mallory@ec.gc.ca

Ecology of Ross's gulls in Penny Strait, Nunavut

Location: Penny Strait, NU

Principal investigator and affiliation: Mark Mallory (Canadian Wildlife Service, Environment Canada)

E-mail: mark.mallory@ec.gc.ca

Contaminants in seabirds at Prince Leopold Island and Coats Island, Nunavut

Locations: Prince Leopold and Coats Islands, NU

Principal investigator and affiliation: Mark Mallory (Canadian Wildlife Service, Environment Canada)

E-mail: mark.mallory@ec.gc.ca

Seabird ecology and contaminants at Cape Vera, Devon Island

Location: Cape Vera, Devon Island, NU

Principal investigator: Mark Mallory (Canadian Wildlife Service, Environment Canada)

E-mail: mark.mallory@ec.gc.ca

Demography, behaviour and prey relations of arctic wolves

Location: Eureka, Ellesmere Island, NU

Principal investigator and affiliation: L. David Mech (Biological Resources Discipline, United States Geological Survey, and University of Minnesota)

Web site: www.davemech.org

Hornaday River water quality and quantity

Location: Hornaday River, N.W.T. (based out of Inuvik, N.W.T.)

Principal investigator and affiliation: Neil Mochnacz (Arctic Research Division, Fisheries and Oceans Canada)

E-mail: neil.mochnacz@dfo-mpo.gc.ca

Plant dynamics on Bylot Island: biotic interactions and climate change

Location: Bylot Island, NU

Principal investigator and affiliation: Line Rochefort (Département de phytologie et Centre d'études nordiques, Université Laval)

Web site: www.cen.ulaval.ca/faune.html

Mercury in the outer Mackenzie Delta and Beaufort Sea

Locations: Mackenzie Delta, N.W.T., and the Beaufort Sea

Principal investigator and affiliation: Gary Stern (Fisheries and Oceans Canada)

E-mail: sternG@dfo-mpo.gc.ca

Sources of methyl mercury (and greenhouse gases) in the High Arctic

Locations: Resolute, Cornwallis Island, and Lake Hazen, Ellesmere Island, NU

Principal investigator and affiliation: Vincent St. Louis (Department of Biological Sciences, University of Alberta)

E-mail: vince.stlouis@ualberta.ca

Levels and effects of contaminants on glaucous gull chicks in the Canadian Arctic

Location: Karrak Lake (Queen Maud Gulf Bird Sanctuary) and Devil's Island, Cardigan Strait, NU

Principal investigator and affiliation: Mark Wayland (Canadian Wildlife Service, Environment Canada)

E-mail: mark.wayland@ec.gc.ca

Thule archaeological site at Resolute, NU.

SUSTAINABLE COMMUNITIES AND CULTURE

Northern communities face many challenges related to changing climate, rapid population growth, globalization and numerous other factors. The vibrant and rich cultures of Canada's northern Aboriginal peoples and their long histories provide many communities with a strong sense of their past and a foundation for moving into the future. Renewed importance has developed for passing Traditional Knowledge from Elders to younger generations, so that youth understand their history, culture and environment. Archaeological projects supported by the PCSP are exploring the history of human habitation of the North, while other studies are assessing natural hazards and their potential influences on northern communities. Many projects involve collaborations with northern residents to examine issues, using both Traditional Knowledge and other scientific methods.

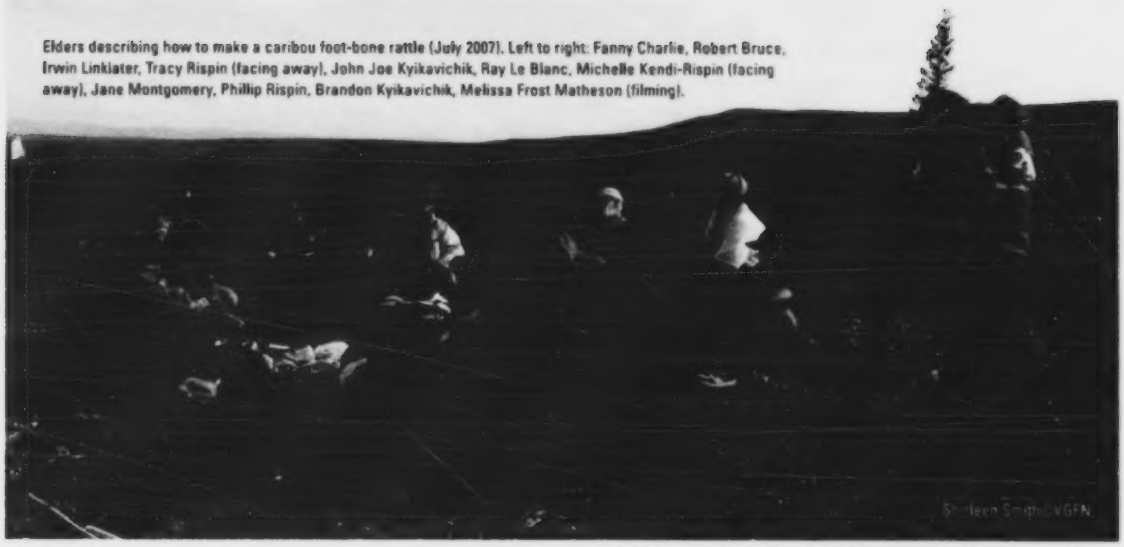
Van Tat Gwich'in Cultural Technology Project

Principal investigators: Shirleen Smith and the Vuntut Gwitchin Government Heritage Branch

Research projects designed and conducted by northern communities can effectively create opportunities for the transfer of Traditional Knowledge and develop information that is of particular importance to a community. The Vuntut Gwitchin Government Heritage Branch has begun a four-year project in the Old Crow area of the Yukon based on Traditional Knowledge and oral history. Community members plan and conduct all aspects of the project, and Shirleen Smith is the project's research coordinator. The project's pilot year, 2007–08, included a week-long visit to the Diniizhoo (Potato Hill) area, located west of Van Tat (Old Crow Flats). This area has special significance to the people of Old Crow as an ancient gathering place.

This project is examining the relationship between the natural and social environments and Van Tat Gwich'in technologies, which include both knowledge and objects. Several culturally important locations were visited by 27 community members (including Elders and youth), project team members and researchers. Participants were involved in seminars, technology demonstrations, traditional games, interviews and the examination of archaeological sites. The research team has developed five educational, interpretive and training materials packages from this project and continues to update its oral history collections with new knowledge.

Interview at Anti'rt: Mary Jane Moses and Stephen Frost, Sr. Shirleen Smith©VGFN



Elders describing how to make a caribou foot-bone rattle (July 2007). Left to right: Fanny Charlie, Robert Bruce, Irwin Linklater, Tracy Rispin (facing away), John Joe Kyikavichik, Ray Le Blanc, Michelle Kendi-Rispin (facing away), Jane Montgomery, Phillip Rispin, Brandon Kyikavichik, Melissa Frost Matheson (filming).

The results of this project will be of particular significance to the Vuntut Gwitchin Government through its applications to land use planning; educating community members and the public; transmitting information on culture, history and the environment; and preserving language. The high level of community involvement in this project results in many outreach and community engagement activities. This research is the foundation of programs and exhibits at the John Tizya Centre, which opened in July 2008 as a joint project with Vuntut Gwitchin Government and Parks Canada. A book on Van Tat Gwich'in history, based on oral history collected, in part, during PCSP-supported research between 2000 and 2005, is being published.

"The foundation of our projects is oral history and knowledge specific to Van Tat Gwich'in of lands and technologies. The current project seeks to build on the information collected in previous research and synthesize and deliver knowledge to community members in a multigenerational setting."

- Shirleen Smith

Culture continuity and change in the interior of southern Baffin Island

Principal investigators: S. Brooke Milne (University of Manitoba), Robert W. Park (University of Waterloo) and Douglas R. Stenton (Government of Nunavut)

History plays a major role in defining culture, and understanding human history in Canada's North is important to many northern communities. The Canadian Arctic has a long history of human occupation. Archaeologists refer to the original inhabitants of the Arctic as Palaeo-Eskimos, and their occupation of the land is divided into three periods, including Pre-Dorset (2250-800 BC), Transitional (800–400 BC) and Dorset (400 BC–1000 AD). After this time, the Thule culture appeared (1000–1600 AD), before today's Inuit cultures.

S. Brooke Milne and colleagues are studying the long-term cultural history of southern Baffin Island. During the summer of 2007, the research team, including a student from Igloolik, Nunavut, excavated an archaeological site at Mingo Lake. The site was part of a large Palaeo-Eskimo habitation composed of multiple structures. Thousands of artifacts, including stone tools and well-preserved animal remains, were collected. Radiocarbon dating of artifacts showed that the Mingo Lake sites were occupied by Pre-Dorset and Dorset peoples. The excavation indicated that Mingo Lake was an important area for hunting caribou and obtaining stone from local supplies of chert to make tools.

The use of the site by Dorset people is particularly significant because there are few sites on Baffin Island that show their occupation of inland areas, and none have such well-preserved caribou remains and tools as those found in this study. The artifacts from this site suggest continuity in the seasonal use of this site and its local resources. People used the site in summer and followed the same hunting and consumption practices throughout the approximately 2400 years that the area was occupied. Use of the area was also more prolonged and intensive than previously thought. The long-term occupation of this site is of particular importance for understanding the Transition period between the Pre-Dorset and Dorset cultures.

Further analysis will compare the pattern of artifacts at this site with records of regional climate changes to assess how Palaeo-Eskimo people adapted to their changing environment, particularly through the Transitional period.

"We have identified new sites dating to the earliest period of human colonization on southern Baffin Island, and these sites will allow us to explore how people were using the inland ecosystem very early on in Nunavut's history."

- S. Brooke Milne, University of Manitoba

Field team members at an archaeological site at Lake Mingo, southern Baffin Island.

Projects focused on sustainable communities and culture

Mackenzie Delta Heritage Research Project

Location: Kugmallit Bay, N.W.T.

Principal investigator and affiliation: Charles D. Arnold (Government of the Northwest Territories)

E-mail: Charles_Arnold@gov.nt.ca

Coastal impacts and climate-change adaptation options in Arctic communities

Locations: Pond Inlet and Cape Charles Yorke, Baffin Island, and Griffith Island, NU

Principal investigator and affiliation: Donald Forbes (Geological Survey of Canada – Atlantic, Natural Resources Canada)

E-mail: dforbes@nrcan.gc.ca

Dynamic Inuit social strategies in changing environments: Traditional Knowledge and archaeology at Huluraq

Location: Huluraq, Victoria Island, NU

Principal investigator and affiliation: Max Friesen (Department of Anthropology, University of Toronto)

E-mail: max.friesen@utoronto.ca

The Iqaluktuuq Project: community-based research into long-term Inuit culture history

Location: Ekalluk River, Victoria Island, NU

Principal investigator and affiliation: Max Friesen (Department of Anthropology, University of Toronto)

E-mail: max.friesen@utoronto.ca

Dall's sheep, grizzly bear and wolf interactions in the Richardson Mountains

Locations: Inuvik, Aklavik, Fort McPherson, Tsiigehtchic and the Goodenough Mountain area, N.W.T.

Principal investigator and affiliation: Catherine Lambert Koizumi (Gwich'in Renewable Resource Board, Government of the Northwest Territories)

E-mail: wildlife@grrb.nt.ca

High Arctic Thule Project: Resolute Bay

Location: Resolute, Cornwallis Island, NU

Principal investigator and affiliation: Robert McGhee (Research and Collections Branch, Canadian Museum of Civilization)

E-mail: robert.mcghee@civilization.ca

Culture continuity and change in the interior of southern Baffin Island: revisiting the Pre-Dorset/Dorset Transition

Location: Mingo Lake, southern Baffin Island, NU

Principal investigators and affiliations: S. Brooke Milne (University of Manitoba), Robert W. Park (University of Waterloo) and Douglas R. Stenton (Government of Nunavut)

E-mail: milnes@cc.umanitoba.ca

Return to Sarvalik: documenting Traditional Knowledge and ways of life before settlement

Locations: Clyde River and Sarvilik Fiord area, Baffin Island, NU

Principal investigator and affiliation: Joelie Sangura (Ilisaqsivik Society)

E-mail: tharig@qiniq.com

Regional impacts of climate change: sea ice and human history of the Northwest Passage

Locations: Multiple locations on Somerset Island and the Boothia Peninsula, NU

Principal investigator: James M. Savelle (Department of Anthropology, McGill University)

E-mail: james.savelle@mcgill.ca

Van Tat Gwich'in Cultural Technology Project

Locations: Van Tat Gwich'in traditional territory and Old Crow, Y.T.

Principal investigators and affiliation: Shirleen Smith and Vuntut Gwitchin First Nation Heritage Branch (Natural Resources Department, Vuntut Gwitchin Government)

E-mail: xmith@interbaun.com and mwilliams@vgfn.net

Helluland Archaeology Project

Locations: Southern Baffin Island, NU

Principal investigator and affiliation: Pat Sutherland (Research and Collections Branch, Canadian Museum of Civilization)

E-mail: patricia.sutherland@civilization.ca

CLIMATE CHANGE

As documented in numerous studies and scientific assessments, Earth's climate is changing. Nowhere have these changes been more evident than in the Arctic. Changes in temperature and precipitation affect vegetation, wildlife, permafrost and water resources, which in turn influence northern communities. New safety issues are also arising due to changing sea ice and weather conditions. In addition, the Arctic is a key controller of the global climate system, such that changes in the Arctic have important implications for climate in other regions of the world. Climate change research projects supported by the PCSP are investigating various aspects of climate change and its influences on the North. These projects can be broadly grouped into two major theme areas: detection and impacts, and the carbon cycle and greenhouse gases.

Resolute, Nunavut

Climate change: detection and impacts

While significant recent warming has been observed in almost all parts of the Arctic, detection of climate change requires that these short-term trends be placed in a longer-term context of past climate variability. Given the extremely sparse instrumental climate records for the Arctic, which are limited to the past 50 years or so, proxy climate records preserved in ice cores and lake sediments provide an invaluable record of past changes in atmospheric composition and climate. Many landscape and ecosystem components of the Arctic are highly sensitive to climate changes, including sea ice, glaciers, permafrost, wildlife and vegetation. Climate change impact studies focus on changes in these systems in response to past and ongoing climate changes, and provide insights into future challenges to be addressed through adaptation.

The dynamic response of arctic glaciers to global warming

Principal investigators: Martin Sharp (University of Alberta), Jeff Kavanaugh (University of Alberta) and Dave Burgess (Canada Centre for Remote Sensing, Natural Resources Canada)

Glaciers and ice caps cover approximately 25 percent of the Queen Elizabeth Islands and approximately 10 percent of all islands in the Canadian Arctic. They are extremely sensitive indicators of climate change, as glacier growth and recession are closely related to temperature and precipitation, which determine annual ice accumulation and ablation. Some glaciers terminate in the sea, which leads to calving along the edge (terminus) and potentially rapid rates of ice loss.

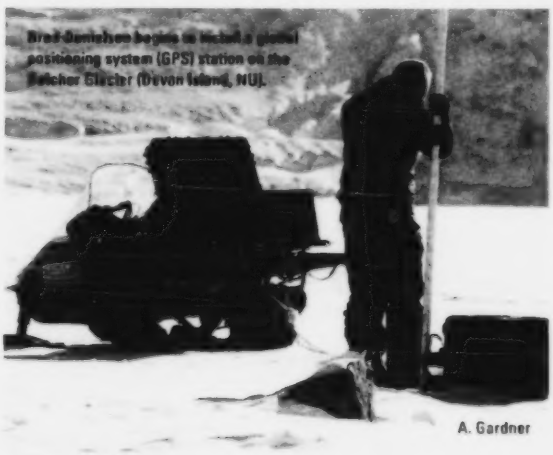
Through two PCSP-supported projects in 2007, Martin Sharp and colleagues are documenting changes in the extent and volume of the Devon Island Ice Cap in the eastern Canadian Arctic to understand how the ice cap is responding to climate warming. One of these projects is the Canadian component of a major International Polar Year project titled Glaciodyn, conducted in collaboration with Gwenn Flowers (Simon Fraser University), Sarah Boon (University of Lethbridge) and Lev Tarasov (Memorial University). The research team is particularly interested in determining how fast-flowing outlet glaciers that terminate in marine waters are responding to climate change.

Travelling by snowmobile across the Devon Island Ice Cap. A. Gardner

Therefore, one area of focus is the Belcher Glacier, the ice cap's largest and fastest-flowing outlet glacier.

The team's observations and analysis will improve modelling of ice caps and ice sheets, which are significant factors influencing global sea level. Improved modelling capabilities will enhance scientists' ability to predict changes in arctic land ice volume and associated sea level changes. While such reliable models are being developed, ice cap and glacier monitoring networks, such as the one operated by this research team, are integral to detecting and quantifying unexpected changes.

Martin Sharp is a strong proponent of effective communication between scientists and non-scientists and recently was chosen as an Aldo Leopold Leadership Fellow by the Woods Institute for the Environment at Stanford University. His ongoing research at Devon Island Ice Cap was highlighted in a news article printed in several major Canadian newspapers in June 2008.



Bret-Denichen begins to install a global positioning system (GPS) station on the Belcher Glacier (Devon Island, NU).

A. Gardner

"This work helps us understand what arctic ice caps are contributing to current sea level change and how the contribution has changed in the recent past."

- Martin Sharp

Permafrost monitoring in Mackenzie Valley

Principal investigators: Mark Nixon and Caroline Duchesne (Geological Survey of Canada, Natural Resources Canada)

Permafrost underlies approximately half of Canada. The term refers to ground that remains at or below the freezing point throughout the year. Warming ground temperatures tend to increase the thickness of the ground that seasonally thaws (the active layer) and will lead to the melting of any ground ice within this thaw zone. These changes can cause surface and slope instability, in addition to altering hydrology and vegetation.

Permafrost strongly influences infrastructure design and performance as well as resource development activities in the Arctic. In addition to problems arising from ground instability, increasing ground temperatures also reduce the strength that permafrost provides as a foundation for infrastructure. Finally, permafrost thawing, particularly in peatlands, can result in the release of methane, a powerful greenhouse gas, formerly trapped in frozen ground.

Mark Nixon and Caroline Duchesne are part of a Geological Survey of Canada project that has been monitoring active layer changes across a 1400-km transect along the Mackenzie River for 17 years. Extending from the boreal forest of Fort Simpson to the tundra of the Beaufort Sea coast, the transect includes 50 study sites in both discontinuous and continuous permafrost.

Data from annual surveys indicate that active layer thickness changes are most closely related to local influences on permafrost conditions, such as ground surface disturbance. However, there is also a positive relationship between melt season length and air temperature and active layer thickness at most sites. Thaw was particularly pronounced during the extremely warm summers of 1998 and 2006.

Understanding changing permafrost conditions is important for assessing surface stability, the potential for frost heave and the appropriate infrastructure design in a given area. The local and regional data developed through this research have

A permafrost thaw monitoring tube near Inuvik, NT. M. Nixon

been used in designs for the Mackenzie gas pipeline and related environmental assessments, and 10 of the monitoring sites are part of the International Permafrost Association's Circumpolar Active Layer Monitoring Program. Outreach components of this project have included providing temperature sensors for the permafrost display at the Inuvik Western Arctic Regional Visitors' Centre.

"Measurements from this transect will be used to help model climate change impacts on near-surface permafrost in this fragile environment."

- Mark Nixon

Limnology and paleoecology of lakes

Principal investigator: John P. Smol (Queen's University)

Lakes and ponds are ubiquitous features of Canada's subarctic and arctic landscapes and are present all the way to Ward Hunt Island at the country's northern extreme. Some of these water bodies are important as sources of community drinking water and as locations for household, commercial and recreational fisheries. Lakes and ponds also have considerable scientific significance and are among the most important sources of proxy climate records in the Arctic. Sediments recovered from these water bodies can provide records of past climate change that extend for several thousand years and, in some cases, provide subannual resolution of changes in lake conditions.

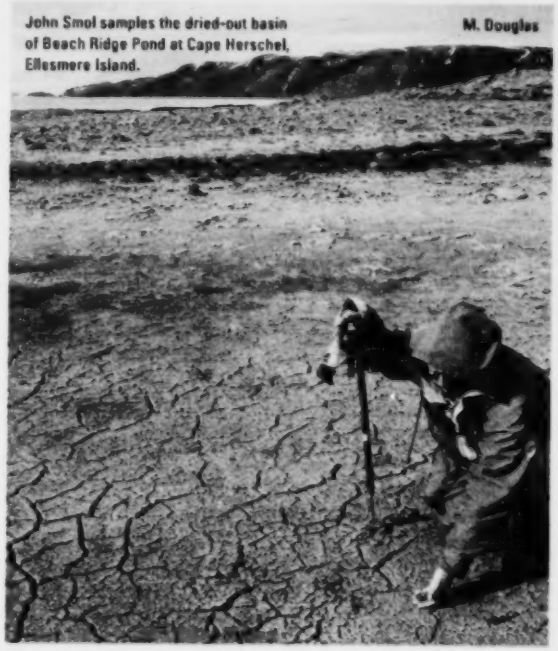
Research undertaken by John Smol, Marianne Douglas (University of Alberta) and colleagues at Cape Herschel on eastern Ellesmere Island combines observational data of lakes and ponds with multiproxy analysis of sedimentary records that cover many millennia. The team has been sampling water and sediments from a group of ponds in the study area since 1983. In the summer of 2006, it observed that several of the shallower ponds were completely dry, and monitoring instruments at the site indicated that the ponds had also dried up in 2005.

The drying trends have continued in subsequent seasons. Not only were these the first years that the ponds had dried up in a quarter century of observation; it was likely the first time they had been dry since they were formed following local deglaciation several thousand years ago. The research team came to this conclusion based on paleoliminological analysis of several environmental indicators, including diatoms (fossil algae). Ponds that have dried out completely have reached the final ecological threshold for aquatic ecosystems, because pond plants and organisms can no longer survive.

This research has documented changes in local conditions through time, and it demonstrates that the dramatic recent changes are a product of regional warming. The current pond conditions represent a culmination of marked changes in aquatic community structure beginning in the 19th century. The ponds continue to be monitored.

"Our data place recent climate warming events into a broader temporal perspective. Our ongoing limnological and ecological studies on the Cape Herschel ponds show how these sensitive ecosystems are responding to the most recent warming."

- John Smol



John Smol samples the dried-out basin of Beach Ridge Pond at Cape Herschel, Ellesmere Island. M. Douglas

Measuring the carbon dioxide flux from a thaw pond on Bylot Island, NU, and its chemical properties. I. Laurion

Project researchers shared the findings of this ongoing work through public lectures in Iqaluit in 2006 and 2008. The desiccated ponds at Cape Herschel drew considerable media attention after a major paper was published by the research team in 2007 in the prestigious journal *Proceedings of the National Academy of Sciences*.

Climate change: the carbon cycle and greenhouse gases

The composition of Earth's atmosphere, particularly the concentration of greenhouse gases (GHGs), is a critical factor regulating Earth's temperature. Large volumes of carbon are stored in the land and waters of Canada's Arctic and are being impacted by the rapid climate changes now occurring. The PCSP supports research projects that are examining how the Arctic contributes to the global carbon cycle and what the present and likely future role of the Arctic is with respect to being a source or a sink of carbon dioxide, methane and other GHGs.

Microbial diversity and greenhouse gas emissions from thaw ponds

Principal investigator: Isabelle Laurion (Institut national de la recherche scientifique and Centre d'études nordiques)

Arctic and subarctic areas contain the largest system of peat bogs on the planet. These bogs store vast quantities of organic carbon, with arctic regions containing more than half of the world's organic carbon that is stored in the ground. As the climate warms, degradation of permafrost releases this carbon into water bodies, and components of this carbon are released to the atmosphere. This can set up a positive feedback in the climate system by further increasing atmospheric concentrations of GHGs (e.g. carbon dioxide) and accelerating permafrost degradation.

Isabelle Laurion and colleagues are studying ponds in Sirmilik National Park on Bylot Island, Nunavut, to improve estimates of carbon sources and sinks and examine their relationships to climate change. This is one of only a few studies that have examined GHG emissions in Canadian arctic aquatic environments.

After ice-rich ground has melted, ponds form in the resulting ground depressions. These thaw ponds have high biological diversity and productivity, with microbial communities (groups of microscopic organisms living in the same location) playing major roles in the production of GHGs and the transformation and storage of the various forms of carbon. The team has found that thaw ponds tend to have high concentrations of dissolved organic matter and that they release more carbon to the atmosphere than they are able to sequester. In other words, the ponds serve as sources of GHGs, rather than sinks.

The research team also observed degradation of pond habitat between 2005 and 2007, and continued permafrost melt may result in complete pond drainage and habitat loss. Such work demonstrates the dynamic nature of lakes and ponds, features too small to be incorporated in most climate models but of significant importance to the overall carbon cycle that controls global climate.

Results from this study are being compared with those of colleagues studying similar sites on Axel Heiberg Island and northern Ellesmere Island as components of the IPY project MERGE. Study findings were communicated to the community of Pond Inlet as part of a public presentation about projects being conducted on Bylot Island.

"This study will contribute to producing Canadian expertise on the diversity of polar organisms and better knowledge of their distribution and function in this extreme environment."

- Isabelle Laurion

Projects focused on climate change issues

DETECTION AND IMPACTS

Geology of northwest Ellesmere Island: sulphur spring and paleoclimate change

Locations: North Greely Fiord, Borup Fiord Pass, Elmerson Peninsula and North Otto Glacier, Ellesmere Island, NU

Principal investigator and affiliation: Benoit Beauchamp (Arctic Institute of North America and Department of Geology and Geophysics, University of Calgary)

E-mail: bbeaucha@ucalgary.ca

Submerged coastal basins at Sachs Harbour: stratigraphy, evolution and water chemistry

Location: Sachs Harbour, N.W.T.

Principal investigator and affiliation: Trevor Bell (Geography Department, Memorial University of Newfoundland)

E-mail: tbell@mun.ca

Permafrost and climate change, western arctic coast, Canada

Locations: Inuvik, Paulatuk and Garry Island, N.W.T., and Herschel Island and Old Crow, Y.T.

Principal investigator and affiliation: C.R. Burn (Department of Geography and Environmental Studies, Carleton University)

E-mail: christopher_burn@carleton.ca

The role of ground ice in arctic coastal climate change: impacts and feedbacks

Location: Herschel Island, Y.T.

Principal investigator and affiliation: Nicole Couture (Department of Geography, McGill University)

E-mail: Nicole.couture@mail.mcgill.ca

Foxe Basin polar bear population delineation

Locations: Locations in Foxe Basin (based out of Igloolik, Repulse Bay, Cape Dorset and Coral Harbour, NU)

Principal investigator and affiliation: Andrew Derocher (Department of Biological Sciences, University of Alberta)

E-mail: derocher@ualberta.ca

Movement patterns and dispersal of juvenile polar bears in the Beaufort Sea

Locations: Locations on the Beaufort Sea (based out of Tuktoyaktuk, N.W.T.)

Principal investigator and affiliation: Andrew Derocher (Department of Biological Sciences, University of Alberta)

E-mail: derocher@ualberta.ca

Characterization of freshwater biological indicators and paleolimnological analyses from Cape Herschel and area, Ellesmere Island, Nunavut

Locations: Cape Herschel, Ellesmere Island, NU

Principal investigator and affiliation: Marianne Douglas (Department of Earth and Atmospheric Sciences and Canadian Circumpolar Institute, University of Alberta)

E-mail: Marianne.douglas@ualberta.ca

The Polar Environment Atmospheric Research Laboratory

Location: Eureka, Ellesmere Island, NU

Principal investigator and affiliation: James Drummond (Department of Physics, University of Toronto)

E-mail: james.drummond@utoronto.ca

Web site: www.candac.ca

Glaciological investigations at Expedition Fiord, Axel Heiberg Island, NU: White and Baby Glaciers

Location: Expedition Fiord, Axel Heiberg Island, NU

Principal investigators and affiliation: Miles Ecclestone and Graham Cogley (Geography Department, Trent University)

Web site: www.trentu.ca/academic/geography/glaciology/glaciology.htm

Environmental change across the NW Canadian Arctic Archipelago: Ice Age to present

Locations: Prince Patrick Island and Banks Island, N.W.T.

Principal investigator and affiliation: John England (Department of Earth and Atmospheric Sciences, University of Alberta)

E-mail: john.england@ualberta.ca

Quantifying paleoclimate from high-resolution lacustrine sequences in the High Canadian Arctic

Location: Sawtooth Lake, Ellesmere Island, NU

Principal investigators and affiliations: Pierre Francus and Nicoleta Ciobanas (Centre Eau, Terre et Environnement, Institut national de la recherche scientifique)

E-mail: pfrancus@ete.inrs.ca

Old Crow basin, northern Yukon: developing analogues for a future warmer climate

Location: Old Crow Flats, northern Y.T.

Principal investigator and affiliation: Duane Froese (Department of Earth and Atmospheric Sciences, University of Alberta)

Web site: www.ualberta.ca/~duane

Postglacial paleoclimatology of the central Canadian arctic islands

Locations: Fosheim Peninsula, Ellesmere Island and Prince of Wales Island, NU

Principal investigator and affiliation: Konrad Gajewski (Department of Geography, University of Ottawa)

E-mail: gajewski@uottawa.ca

Web site: www.lpc.uottawa.ca

Biology of tundra bird populations: demographics, trophic interactions and climate change

Location: Bylot Island, NU

Principal investigators and affiliations: Gilles Gauthier (Département de biologie and Centre d'études nordiques, Université Laval) and Joël Bety (Département de biologie and Centre d'études nordiques, Université du Québec à Rimouski)

Web site: www.cen.ulaval.ca/bylot/

Qamutiks and snowmobiles on ice near Pond Inlet, NU

Ecosystem development in polar deserts

Location: Alexandra Fiord, Princess Marie Bay, Sverdrup Pass and a location near Eureka, Ellesmere Island, NU

Principal investigator and affiliation: Greg Henry (Department of Geography, University of British Columbia)

E-mail: ghenry@geog.ubc.ca

Buoys-on-Ice 2007

Locations: Arctic Ocean locations (based out of Eureka, NU)

Principal investigators and affiliations: Edward Hudson (Meterological Service of Canada, Environment Canada) and participants of the International Arctic Buoy Program (IABP)

E-mail: edward.hudson@ec.gc.ca

Web site: iabp.apl.washington.edu

Terrestrial trophic interactions in the ecology of western arctic small mammals

Locations: Pauline Bay, Herschel Island, Y.T., and Walker Bay, N.W.T.

Principal investigator and affiliation: Charles Krebs (Department of Zoology, University of British Columbia)

E-mail: krebs@zoology.ubc.ca

The impact of climate variability on watershed fluxes: integrated watershed research at Cape Bounty, Melville Island

Location: Cape Bounty, Melville Island, NU

Principal investigators and affiliations: Scott Lamoureux and Melissa Lafrenière (Department of Geography, Queen's University)

Web site: geog.queensu.ca/cbawo/

Biogeochemistry of lakes in the Mackenzie Delta

Location: Mackenzie Delta, based out of Inuvik, N.W.T.

Principal investigator and affiliation: Lance F.W. Lesack (Department of Geography, Simon Fraser University)

E-mail: Lance_Lesack@sfu.ca

Hydrological studies, Mackenzie Delta region

Locations: Inuvik, Denis Lagoon and Richards Island, N.W.T.

Principal investigator and affiliation: Philip Marsh (National Water Research Institute, Environment Canada)

E-mail: Philip.Marsh@ec.gc.ca

The effects of summertime melt on stable water isotope composition, snow stratigraphy and snowpack temperatures on the Prince of Wales Icefield, Ellesmere Island, Nunavut

Location: Prince of Wales Icefield, Ellesmere Island, NU

Principal investigator and affiliation: Shawn Marshall (Department of Geography, University of Calgary)

E-mail: shawn.marshall@ucalgary.ca

Glacio-hydrological characterization of a high arctic polythermal glacier

Location: Bylot Island, NU

Principal investigator and affiliation: Brian J. Moorman (Department of Geography and Department of Geology and Geophysics, University of Calgary)

E-mail: moorman@ucalgary.ca

Permafrost monitoring in Mackenzie Valley

Locations: Locations in Mackenzie Valley, N.W.T. (based out of Inuvik, N.W.T.)

Principal investigators and affiliations: Mark Nixon and Caroline Duchesne (Geological Survey of Canada–Northern Canada, Natural Resources Canada)

E-mail: mnixon@nrcan.gc.ca

Web site: nsidc.org/data/ggd353.html

Global change and animal population impacts on northern lake ecosystems

Locations: Locations on southeastern Southampton Island, NU (based out of Coral Harbour, NU)

Principal investigator and affiliation: Reinhard Pienitz (Centre d'études nordiques, Université Laval)

Web site: www.cen.ulaval.ca/paleo/index.html

Dendroclimatic and paleoecological investigations of the Mackenzie Delta, Northwest Territories

Locations: Inuvik and locations on Mackenzie Delta, N.W.T.

Principal investigator and affiliation: Michael Pisaric (Department of Geography, Carleton University)

E-mail: michael_pisaric@carleton.ca

Web site: www.carleton.ca/~mpisaric

The biophysical significance of groundwater and ground ice in cold polar environments

Locations: Expedition Fiord and Whitsunday Bay, Axel Heiberg Island, and Eureka, Ellesmere Island, NU

Principal investigator and affiliation: Wayne Pollard (Department of Geography, McGill University)

E-mail: pollard@geog.mcgill.ca

Sensitivities of high-latitude lakes to climatic and development disturbances

Location: Inuvik, N.W.T.

Principal investigator and affiliation: Terry Prowse (Department of Geography, University of Victoria)

E-mail: prowset@uvic.ca

Assessment of the arctic char of Quttinirpaaq National Park

Location: Locations in Quttinirpaaq National Park, Ellesmere Island, NU

Principal investigator and affiliation: Jim Reist (Arctic Aquatic Research Division, Fisheries and Oceans Canada)

E-mail: Jim.Reist@dfo-mpo.gc.ca

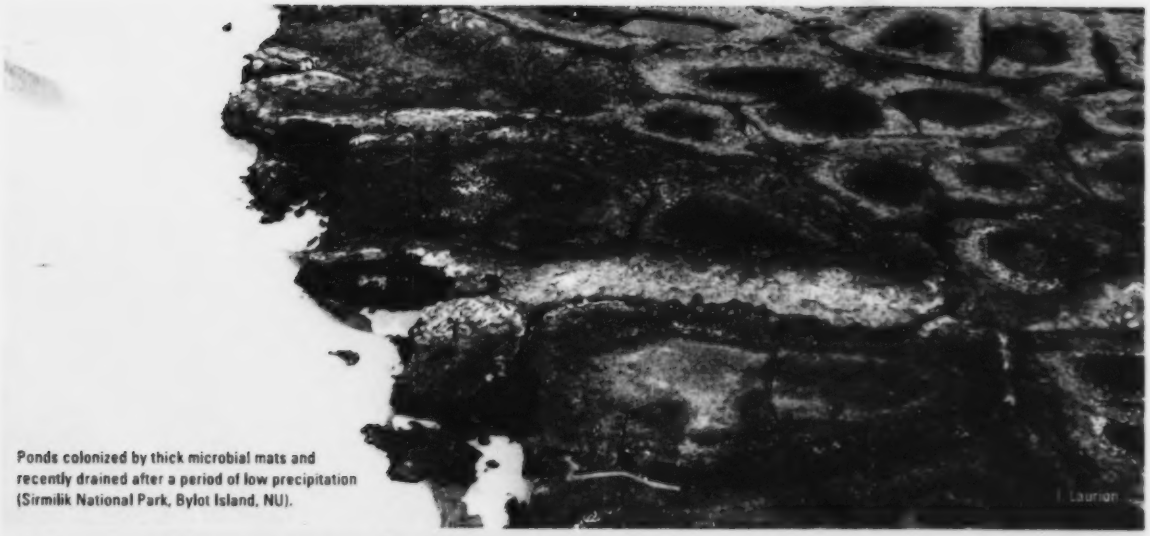
Web site: www.ipy.org/index.php?ipy/detail/arctic_biodiversity_of_chars/

Mesozoic and Cenozoic ecosystems in the Canadian High Arctic

Location: Bylot Island and Devon Crater, Devon Island, NU

Principal investigator and affiliation: Natalia Rybczynski (Canadian Museum of Nature)

E-mail: nrybczynski@mus-nature.ca



Ponds colonized by thick microbial mats and recently drained after a period of low precipitation (Sirmilik National Park, Bylot Island, NU).

I. Laurion

The dynamic response of arctic glaciers to global warming: A Canadian contribution to International Polar Year Project Glaciodyn

Location: Devon Island Ice Cap, NU

Principal investigators and affiliations: Martin Sharp and Jeff Kavanaugh (Department of Earth and Atmospheric Sciences, University of Alberta) and Dave Burgess (Canada Centre for Remote Sensing, Natural Resources Canada)

E-mail: martin.sharp@ualberta.ca

Web sites: arctic.eas.ualberta.ca/ and

people.uleth.ca/~sarah.boon/IPY_page/index.html

Recent thickness changes of the Devon Island Ice Cap and their causes

Location: Devon Island Ice Cap, NU

Principal investigators and affiliations: Martin Sharp and Jeff Kavanaugh (Department of Earth and Atmospheric Sciences, University of Alberta) and Dave Burgess (Canada Centre for Remote Sensing, Natural Resources Canada)

E-mail: martin.sharp@ualberta.ca

Web sites: arctic.eas.ualberta.ca/ and

people.uleth.ca/~sarah.boon/IPY_page/index.html

Limnology and paleoecology of lakes

Location: Cape Herschel, Ellesmere Island, NU

Principal investigator and affiliation: John P. Smol (Department of Biology, Queen's University)

Web site: biology.queensu.ca/~pearl/

Climate control of high arctic lake, fiord and ice shelf ecosystems

Locations: Ward Hunt Island and locations along the northern coast of Ellesmere Island, NU

Principal investigator and affiliation: Warwick F. Vincent (Centre d'études nordiques, Université Laval)

E-mail: warwick.vincent@bio.ulaval.ca

Web site: www.cen.ulaval.ca/merge/

High arctic ground temperature monitoring and contribution to International Polar Year

Location: Hot Weather Creek, Ellesmere Island, NU Principal investigator and affiliation: Anne Walker (Climate Research Division, Environment Canada)

E-mail: anne.walker@ec.gc.ca

Microbial investigations of cold saline springs and permafrost in the High Arctic

Locations: Expedition Fiord, Axel Heiberg Island, and Fosheim Peninsula, Ellesmere Island, NU

Principal investigator and affiliation: Lyle G. Whyte (Department of Natural Resource Sciences, McGill University)

E-mail: Lyle.Whyte@mcgill.ca

Northern paleohydrology (Slave River Delta, N.W.T.) and hydroecology (Old Crow Flats, Y.T.)

Locations: Fort Resolution and Inuvik, N.W.T., and Old Crow, Y.T.

Principal investigator and affiliation: Brent B. Wolfe (Geography and Environmental Studies, Wilfrid Laurier University)

E-mail: bwolfe@wlu.ca

Hydrology of extensive low-gradient high arctic wetlands: an examination of sustainability

Location: Polar Bear Pass, Bathurst Island, NU

Principal investigator and affiliation: Kathy L. Young (Geography Department, York University)

Web site: www.yorku.ca/klyoung

THE CARBON BUDGET AND GREENHOUSE GASES

Climate Change Effects on Canadian Arctic Tundra Ecosystems: interdisciplinary and multi-scale assessments (CiCAT)

Location: Cape Bounty, Melville Island, NU

Principal investigator and affiliation: Greg Henry (Department of Geography, University of British Columbia)

E-mail: ghenry@geog.ubc.ca

Canadian Tundra Ecosystem Carbon Study

Location: Daring Lake Tundra Ecosystem Research Station, N.W.T.

Principal investigator and affiliation: Elyn Humphreys (Department of Geography and Environmental Studies, Carleton University)

E-mail: elyn_humphreys@carleton.ca

Microbial diversity and greenhouse gas emissions of thermokarst ponds

Location: Bylot Island, NU

Principal investigator and affiliation: Isabelle Laurion (Centre Eau, Terre et Environnement, Institut national de la recherche scientifique and Centre d'études nordiques)

E-mail: isabelle.laurion@ete.inrs.ca

Web site: www.inrs-ete.uquebec.ca/professeur.php?page=IsabelleLaurion

Geological complexity of the Mackenzie–Beaufort hydrocarbon resource development region

Locations: Inuvik and Richards Island, N.W.T.

Principal investigator and affiliation: Fred Wright (Geological Survey of Canada – Pacific, Natural Resources Canada)

E-mail: fwright@nrcan.gc.ca

A polar bear on sea ice near Devon Island, NU.

SUSTAINABLE RESOURCE MANAGEMENT

Management of natural resources in the Canadian Arctic, including wildlife, water, petroleum and minerals, is key to ensuring that these resources are available into the future and benefit northern communities. With increased focus on the Arctic and improved access to many northern locations, opportunities are developing for increased economic activity in natural resource fields. However, this development, environmental protection and future resource needs must all be informed by solid scientific knowledge of resource inventories and accessibility. The PCSP supports several research projects that are examining sustainable development and resource management in the North.

Bowhead whale feeding aggregations in the Canadian Beaufort Sea

Principal investigator: Lois Harwood (Arctic Aquatic Research Division, Arctic Science, Department of Fisheries and Oceans Canada, Yellowknife, N.W.T.)

The bowhead whale is an important part of the arctic marine environment and is the only baleen whale (a whale that has baleen instead of teeth) that spends all year in arctic and subarctic waters. It is also an important subsistence resource to the Inuit in arctic Canada, Alaska and Russia, where it is hunted for meat and muktuk. Like many other arctic species, the bowhead whale population is being monitored for distribution, health and behaviour as climate change and human development influence its habitat.

A bowhead whale pod in the southern Beaufort Sea. DFO

In August 2007, Lois Harwood and her research team, including a member of the Inuvik Hunters and Trappers Committee, conducted the first of three years of planned aerial surveys to update knowledge of the distribution of bowhead whales in the southeastern Beaufort Sea. The last major survey had been completed in 1986. In 2007, a total of 170 bowhead whales were counted at the water's surface along 24 north-south transect lines, which extended from 60 to 100 km offshore from the Alaska–Yukon border (141°W) eastward to Cape Bathurst, N.W.T. (128°40'W).

Three main bowhead whale feeding areas were identified in 2007:

- off the Yukon coast between Komakuk Beach and Shingle Point
- near the edge of the continental shelf north of the Mackenzie River estuary
- off the Tuktoyaktuk Peninsula in waters from 20 to 50 m deep

These areas were similar to some of the areas used by the whales in the 1980s, although the 2007 survey showed that whales were more numerous in these feeding areas than they were more than 20 years ago.

In addition, the results of this study were integrated into the mitigation strategy outlined by Department of Fisheries and Oceans regulators and used by one seismic operator to ensure no injury or disturbance to bowhead whales during exploration activities in the study area in the summer and fall of 2007. The plan involved limiting seismic surveys within whale feeding areas to daylight hours only and when no fog was present, which ensured that marine mammal observers could effectively monitor the safety zone area for bowhead whales.

The results of the first year of this ongoing study have been presented to the Tuktoyaktuk Hunters and Trappers Committee, Inuvialuit Game Council and Fisheries Joint Management Committee and discussed at many workshops on energy development and the impacts of seismic sound on marine animals.

"... real-time knowledge of the aggregation areas [that bowhead whales] are using in a given year, provide an opportunity to ... ensure no disturbance or injury to feeding whales, and ... not unjustifiably constrain industry activity in areas with no or limited interest to feeding whales."

- Lois Harwood

The Southampton Island Integrated Geoscience Project

Principal investigators: Joyia Chakungal (Canada–Nunavut Geoscience Office, Natural Resources Canada) and Mary Sanborn-Barrie (Geological Survey of Canada, Natural Resources Canada)

Detailed geological knowledge is essential for identifying and developing energy and mineral resources. In recent decades, natural resources, such as diamonds, metals (copper, nickel, platinum) and hydrocarbons, have been found in several areas of the Canadian Arctic, but the presence and potential of these deposits is not well known in most areas due to a lack of basic geological information.

Joyia Chakungal, Mary Sanborn-Barrie and colleagues are working to fill part of this information gap through the Southampton Island Integrated Geoscience (SIIG) project. This ongoing research began in 2007 with the aim to better understand the island's mineral and energy resource potential.

In 2007, an aeromagnetic survey (measuring changes in Earth's magnetic field from an aircraft) of central and northeastern parts of the island aimed to determine the structure and magnetic properties of Precambrian rocks (more than 550 million years old) that underlie this area. An understanding of how the data are linked to the exposed bedrock was obtained through complementary ground-based mapping of the bedrock and surficial geology.

A collection of more than 720 rock samples and 200 till samples have contributed information on the age, geochemistry, formational history and mineral potential of the island's rock units and glacial deposits. These efforts allowed approximately 25 000 km^2 of the island's bedrock to be mapped in greater detail than was previously available and a model of its ice flow history to be developed. Other ground-based research included geophysical surveys to develop a three-dimensional image of the structure of Earth's interior below the study area.

The SIIG project consulted regularly with the community of Coral Harbour and benefited from involvement of members of the Aiviit Hunters and Trappers Organization who were part of the field team in 2007 and 2008. Prior to fieldwork, classroom visits communicated the interesting information that could be learned via the rock record.

On July 17, 2008, the SIIG project held a community open house, where research summaries were presented, and SIIG project team members showed community members rock and fossil samples, field instruments and maps from their study. This research has also been presented at a number of geoscience venues, including the 2007 Yellowknife Geoscience Forum, 2008 Mineral Exploration Roundup and 2008 Nunavut Mining Symposium.

"The Southampton Island Integrated Geoscience (SIIG) project acquired detailed and updated geoscience information, which will serve to maximize understanding of the prospectivity of this isolated region of Nunavut for mineral and hydrocarbon potential."

- SIIG Research team

Multi-year sea ice in Crozier Strait, Nunavut. M. Johnston

Understanding the decay of multi-year sea ice

Principal investigator: Michelle Johnston (Canadian Hydraulics Centre, National Research Council)

Reductions in the amount of sea ice may make shipping routes through the Canadian Arctic Archipelago that were once impassable into viable shipping options. Historically, much of the Northwest Passage has been blocked by sea ice, but in recent years it has become largely ice-free by late summer. These changes have prompted much discussion about economic development, sovereignty and environmental concerns in the Arctic.

Most sea ice in the Canadian Arctic is first-year ice (forms and melts in one year), but there is also a significant amount of thicker, stronger multi-year ice. Lesser amounts of first-year ice mean that multi-year ice can drift through the Arctic more freely, increasing its hazard to ships and structures. Understanding when multi-year ice is a hazard will help arctic operators recognize the most dangerous sea ice types. Not only will this action prevent damage, but will also prevent pollution in arctic waters due to damaged ships or structures.

Michelle Johnston and colleagues are examining the lifespan of massive pieces of multi-year ice in terms of how their thickness and strength change over time. The research team has studied 24 multi-year ice floes, many of them more than 10 m thick, over a number of years.

During the summer of 2007, the team, which included two residents of Resolute, visited multi-year ice floes in Crozier Strait (northwest of Cornwallis Island, NU) on multiple occasions to measure ice characteristics (thickness, temperature, salinity and strength). For multi-year ice attached to the coastline (landfast ice), ice strength in the uppermost 4 m was reduced by 35 percent from May to July due to an increase of 8°C of ice temperature through the ice profile. This finding will be helpful in assessing the risks that multi-year ice presents to marine traffic and how those risks vary throughout the year. This ongoing research project will expand monitoring to include more multi-year ice floes throughout the ice growth and melt seasons, in various parts of the Arctic.

Study results are being incorporated into a guide that will be used to assist ship and offshore structure operators to reliably detect multi-year ice floes. As the team continues to examine the main influences on multi-year ice decay and drifting patterns, new results will complement ongoing regional observations of sea ice extent.

Presentations on this research have been given to the Canadian Coast Guard, marine and offshore industry officials, the community of Resolute and international ambassadors visiting the PCSP's Resolute facilities. This research was also part of the CBC television special news feature, "The Big Melt."

"Establishing the 'damage potential' of multi-year ice (based upon its thickness and strength) gives operators the ability to design for the most dangerous types of ice and avoid them when possible, ensuring safe and pollution-free operations in the Arctic."

- Michelle Johnston

M. Johnston

Richard Lanthier, Steve Nungak and Matt O'Brien help to conduct measurements on a decaying multi-year ice hummock northwest of Cornwallis Island, NU.

Projects focused on sustainable resource management

BIOLOGICAL RESOURCES

Population biology and nutritional ecology of Ross's geese

Location: Karrak Lake, NU

Principal investigator and affiliation: Ray T. Alisauskas (Wildlife Research Centre, Environment Canada)

E-mail: ray.alisauskas@ec.gc.ca

Survival in arctic geese

Locations: Perry River and Atkinson Point River, NU

Principal investigator and affiliation: Ray T. Alisauskas (Wildlife Research Centre, Environment Canada)

E-mail: ray.alisauskas@ec.gc.ca

The red-throated loon as an environmental indicator for offshore oil and gas activity

Locations: Beaufort Sea coast locations (based out of Inuvik, N.W.T.)

Principal investigator and affiliation: Jessica Beaubier (Canadian Wildlife Service, Environment Canada)

E-mail: jessica.beaubier@ec.gc.ca

Population estimate using DNA darting for grizzly bears in the Inuvialuit Settlement Area, west of Delta eastward

Locations: Inuvik, Tuktoyaktuk, Paulatuk and Rendezvous Lake, N.W.T.

Principal investigator and affiliation: Marsha Branigan (Environment and Natural Resources, Government of the Northwest Territories)

E-mail: marsha_branigan@gov.nt.ca

Rare and threatened species inventory in the northern Yukon

Locations: Buckland Hills, Ptarmigan Bay, Komakuk Beach and Old Crow Flats, Y.T.

Principal investigator and affiliation: Syd Cannings (Department of Environment, Government of Yukon)

E-mail: syd.cannings@gov.yk.ca

Baffin Island goose banding

Location: Nikko Island, NU

Principal investigator and affiliation: Dale Caswell (Canadian Wildlife Service, Environment Canada)

E-mail: dale.caswell@ec.gc.ca

Breeding biology and distribution of eastern high arctic brant in the Queen Elizabeth Islands

Locations: Schei Peninsula, Axel Heiberg Island and Fosheim Peninsula, Ellesmere Island, NU

Principal investigator and affiliation: Kendrew Colhoun (The Wildfowl & Wetlands Trust, U.K.), Gudmundur A. Gudmundsson (Icelandic Institute of Natural History, Iceland), Stuart Bearhop (Centre for Ecology and Conservation, University of Exeter, U.K.), Alyn Walsh (National Parks and Wildlife Service, Ireland) and Austin Reed (Canadian Wildlife Service, Environment Canada)

E-mail: i.webs@virgin.net (K. Colhoun)

Web site: www.irishbrentgoose.org

Ecology of grizzly bears (Ursus arctos) in the Mackenzie Delta oil and gas development area

Locations: Mackenzie Delta locations (based out of Inuvik, N.W.T.)

Principal investigator and affiliation: Andrew E. Derocher (Department of Biological Sciences, University of Alberta)

E-mail: derocher@ualberta.ca

Pacific common eider population status and survival in the Bathurst Inlet area of Nunavut

Location: Nauyak Lake (Bathurst Inlet area), NU

Principal investigators and affiliations: Lynne Dickson and Garnet Raven (Canadian Wildlife Service, Environment Canada)

E-mail: lynne.dickson@ec.gc.ca, garnet.raven@ec.gc.ca

Breeding ecology of common eiders (Somateria mollissima borealis) at St. Helena Island, Nunavut

Location: St. Helena Island, NU

Principal investigator and affiliation: Grant Gilchrist (National Wildlife Research Centre, Environment Canada)

E-mail: grant.gilchrist@ec.gc.ca

Population studies of common and king eider ducks breeding in East Bay, Nunavut

Location: East Bay, Southampton Island, NU

Principal investigator and affiliation: Grant Gilchrist (National Wildlife Research Centre, Environment Canada)

E-mail: grant.gilchrist@ec.gc.ca

Quantifying the response of breeding ivory gulls to sources of natural and human-induced disturbance on the Brodeur Peninsula of Baffin Island, Nunavut

Location: Brodeur Peninsula, Baffin Island, NU

Principal investigator and affiliation: Grant Gilchrist (National Wildlife Research Centre, Environment Canada)

E-mail: grant.gilchrist@ec.gc.ca

Bowhead whale feeding aggregations in the Canadian Beaufort Sea (2007–2009) and their role in the mitigation of effects of seismic underwater noise

Locations: Beaufort Sea locations (based out of Inuvik, N.W.T.)

Principal investigator and affiliation: Lois Harwood (Arctic Aquatic Research Division, Fisheries and Oceans Canada)

E-mail: harwoodl@dfo-mpo.gc.ca

Rat River charr assessment

Location: Fish Creek, northwestern Northwest Territories

Principal investigator and affiliation: Lois Harwood (Arctic Aquatic Research, Fisheries and Oceans Canada)

E-mail: harwoodl@dfo-mpo.gc.ca

Ecology and management of waterfowl populations from the western Canadian Arctic

Locations: Inuvik and western Banks Island, N.W.T.

Principal investigator and affiliation: Jim Hines (Canadian Wildlife Service, Environment Canada)

E-mail: jim.hines@ec.gc.ca

Population analysis of harvested fish species in the Travaillant Lake system

Locations: Travaillant Lake and Travaillant River, N.W.T.

Principal investigator and affiliation: Kimberly L. Howland (Arctic Research Division, Fisheries and Oceans Canada)

E-mail: howlandk@dfo-mpo.gc.ca

Stock assessment of Great Bear Lake trout

Location: Great Bear Lake, N.W.T.

Principal investigator and affiliation: Kimberly L. Howland (Arctic Research Division, Fisheries and Oceans Canada)

E-mail: howlandk@dfo-mpo.gc.ca

Estimating the abundance, composition and distribution of Peary caribou and muskoxen in the high arctic islands of Nunavut

Locations: Eureka, Ellesmere Island, Expedition Fiord, Axel Heiberg Island, and Isachsen, Ellef Ringnes Island, NU

Principal investigator and affiliation: Debbie Jenkins (Department of Environment, Government of Nunavut)

E-mail: pondbiologist@qiniq.com

Fish survey/ecosystem structure of nearshore coastal waters, Yukon North Slope

Location: Phillips Bay, Y.T.

Principal investigator and affiliation: Jim Johnson (Arctic Aquatic Research Division, Fisheries and Oceans Canada)

E-mail: johnsonj@dfo-mpo.gc.ca

Southampton Island goose banding

Location: Coral Harbour area, Southampton Island, NU

Principal investigator and affiliation: Jim Leafloor (Canadian Wildlife Service, Environment Canada)

E-mail: jim.leafloor@ec.gc.ca

Yukon North Slope Grizzly Research Project

Locations: Yukon North Slope area, Y.T.

Principal investigator and affiliation: Ramona Maraj (Department of Environment, Government of Yukon)

E-mail: ramona.maraj@gov.yk.ca

Investigation of Vittrekwa River Dolly Varden

Location: Vittrekwa River tributary, N.W.T.

Principal investigator and affiliation: Nathan Millar (Gwich'in Renewable Resource Board, Government of the Northwest Territories)

Ecology and ecophysiology of high arctic shorebirds

Locations: Alert, Ellesmere Island, NU

Principal investigator and affiliation: R.I.G. Morrison (Canadian Wildlife Service, Environment Canada)

E-mail: guy.morrison@ec.gc.ca

Web sites: www.ec.gc.ca/scitech/default.asp?lang=En&n=457BB692-1 and http://www.cen.ulaval.ca/arcticwolves/index.html

Davis Strait polar bear population inventory and western Hudson Bay (Nunavut jurisdiction) population survey

Locations: Locations along western Davis Strait, NU

Principal investigator and affiliation: Elizabeth Peacock (Wildlife Research Section, Government of Nunavut)

E-mail: epeacock@nunavutwildlife.ca

Study of greater snow goose breeding and migration

Locations: Bylot Island and Eureka, Ellesmere Island, NU

Principal investigator and affiliation: Austin Reed (Canadian Wildlife Service – Québec Region, Environment Canada)

E-mail: austin.reed@ec.gc.ca

Walrus stock definition and enumeration

Location: Locations in Foxe Basin (based out of Resolute and Iqaluit, NU)

Principal investigator and affiliation: Rob Stewart (Arctic Research Division, Fisheries and Oceans Canada)

E-mail: stewartre@dfo-mpo.gc.ca

Assessment of the possible impacts of oil and gas activities in the outer Mackenzie Delta and the nearshore southern Beaufort Sea on polar bears

Locations: Mackenzie Delta and southern Beaufort Sea locations (based out of Inuvik and Tuktoyaktuk, N.W.T.)

Principal investigators and affiliations: Evan Richardson and Ian Stirling (Canadian Wildlife Service, Environment Canada)

E-mail: Evan.Richardson@ec.gc.ca and ian.stirling@ec.gc.ca

Modelling of migratory patterns to spawning and over-wintering areas of harvested fish species in rivers along the Mackenzie Valley Pipeline route

Locations: Inuvik and locations along the Mackenzie River, N.W.T.

Principal investigator and affiliation: Ross Tallman (Arctic Research Division, Fisheries and Oceans Canada)

E-mail: TallmanR@dfo-mpo.gc.ca

GEOLOGICAL AND WATER RESOURCES

United Nations Convention on the Law of the Sea – UNCLOS Program

Location: Arctic Ocean sea ice locations (based out of Alert, NU)

Principal investigator and affiliation: Jon Biggar (Canadian Hydrographic Service, Fisheries and Oceans Canada)

E-mail: biggarj@dfo-mpo.gc.ca

Southampton Island Integrated Geoscience Program (SIIG)

Location: Southampton Island, NU

Principal investigator and affiliation: Joyia Chakungal (Canada–Nunavut Geoscience Office, Natural Resources Canada) and Mary Sanborn-Barrie (Geological Survey of Canada, Natural Resources Canada)

E-mail: jchakung@NRCan.gc.ca

South Wopmay bedrock mapping project and integrated studies

Location: Southern Wopmay Orogen, Gameti area, N.W.T.

Principal investigator and affiliation: Valerie Jackson (Northwest Territories Geoscience Office, Indian and Northern Affairs Canada)

E-mail: valerie_jackson@gov.nt.ca

Web site: www.nwtgeoscience.ca/minerals/southernwopmay.html

Understanding the decay of multi-year ice: an important aspect of climate change

Location: Cruzier Strait (based out of Resolute, NU)

Principal investigator and affiliation: Michelle Johnston (Canadian Hydraulics Centre, National Research Council of Canada)

E-mail: michelle.johnston@nrc-cnrc.gc.ca

Regional geoscience studies and petroleum potential, Peel Plateau and Plain, Northwest Territories and Yukon

Locations: Peel Plateau and Plain, N.W.T. and Y.T.

Principal investigator and affiliation: Adrienne Jones (Northwest Territories Geoscience Office, Government of the Northwest Territories)

Web site: www.nwtgeoscience.ca/petroleum/PeelPlateau.html

Boothia Integrated Geoscience Project – Phase 2

Location: Boothia Peninsula, NU

Principal investigator and affiliation: J. Ryan (Geological Survey of Canada – Pacific, Natural Resources Canada)

E-mail: jryan@NRCan.gc.ca

Coastal and nearshore geohazards in the Mackenzie Delta region

Locations: Southern Beaufort Sea and the Mackenzie Delta, N.W.T.

Principal investigators and affiliation: Steven Solomon and Donald Forbes (Geological Survey of Canada – Atlantic, Natural Resources Canada)

E-mail: ssolomon@nrcan.gc.ca

Stratigraphy, sedimentology, diagenesis and metallogeny of the Society Cliffs Formation and related strata, Borden Basin

Locations: Arctic Bay and multiple locations on northern Baffin Island, NU

Principal investigator and affiliation: Elizabeth Turner (Department of Earth Sciences, Laurentian University)

E-mail: eturner@laurentian.ca

North Baffin Island surficial geology studies: improving exploration and development opportunities

Locations: Pond Inlet and locations on northern Baffin Island, NU

Principal investigator and affiliation: Daniel Utting (Canada–Nunavut Geoscience Office, Natural Resources Canada)

E-mail: uttingdj@gov.ns.ca, djames@nrcan.gc.ca (Don James, CNGO)

Thermal effects of active salt structures in Axel Heiberg Island

Location: White Glacier, Axel Heiberg Island, NU

Principal investigator and affiliation: Marcos Zentilli (Department of Earth Sciences, Dalhousie University)

E-mail: Zentilli@dal.ca

Tim Barfoot (University of Toronto) uses a sensor cart as a data collection platform at the Haughton Mars Project site on Devon Island, NU. This surrogate for a Mars rover will be tested in the Haughton Crater, which has terrain similar to the Mars landscape.

Anna Lisa Paul (University of Florida) examines a small plant as part of a vegetation growth study at Haughton Crater. This research will contribute to a vegetation study on a space shuttle mission.

PLANETARY SCIENCE AND ASTRONOMY

The Canadian Arctic has many varied and unique landscapes, including some locations that could be called "moonscapes" due to their dry, rocky conditions and structural similarities to landscapes on the Moon or even Mars. Each year, a number of PCSP-supported projects conduct research in the field of planetary science at select sites in the Canadian Arctic. These studies include comparing the geology of Earth and Mars, investigating the influence of water on each planet, examining tiny organisms that can survive in extreme environments and testing new technology for working on Mars or the Moon in the future.

Projects focused on planetary science and astronomy

Astronomical site testing on Ellesmere Island

Location: Yelverton Bay, Ellesmere Island, NU

Principal investigator and affiliation: Ray Carlberg (Department of Astronomy and Astrophysics, University of Toronto)

E-mail: carlberg@astro.utoronto.ca

Haughton-Mars Project (HMP)

Location: Haughton Crater, Devon Island, NU

Principal investigator and affiliation: Pascal Lee (Mars Institute)

E-mail: pascal.lee@marsinstitute.info

Winter to Spring Transition in arctic permafrost on Devon Island studied as a Mars base simulation

Location: Mars Arctic Research Station, Devon Island, NU

Principal investigator and affiliation: Christopher McKay (Space Science Division, NASA Ames Research Center)

E-mail: cmckay@mail.arc.nasa.gov

Planetary analogue research studies at the Haughton Impact Structure, Devon Island

Location: Haughton Crater, Devon Island, NU

Principal investigator and affiliation: Gordon Osinski (Canadian Space Agency)

E-mail: gosinski@uwo.ca

Planetary analogue research studies at the McGill Arctic Research Station, Axel Heiberg Island

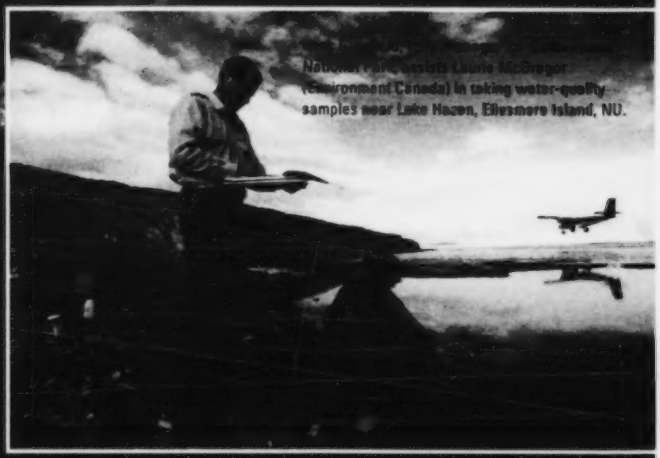
Location: Expedition Fiord, Axel Heiberg Island, NU

Principal investigator and affiliation: Gordon Osinski (Canadian Space Agency)

E-mail: gosinski@uwo.ca

NATIONAL PARKS AND WEATHER STATION OPERATIONS

Canada's national parks conduct annual field operations to study and monitor each park's environmental and cultural resources to ensure proper environmental management into the future. Many national parks in Canada's North use aircraft coordinated by the PCSP to conduct their field activities. Operations often include assessments of natural hazards for visitors to the park, servicing equipment in or removing it from remote areas, maintaining historical sites and conducting research in such fields as archaeology and wildlife management. Environment Canada's arctic weather stations are also monitored regularly to ensure continuing proper functioning and data collection.



National Parks ecologist Laurie McGregor (Environment Canada) in taking water-quality samples near Lake Hazen, Ellesmere Island, NU.

Quttinirpaaq National Park Operations 2007

Principal investigator: Ross Glenfield (Parks Canada)

Located on northern Ellesmere Island, Nunavut, Quttinirpaaq National Park is Canada's most northerly national park and is representative of the Eastern High Arctic Natural Region. In this polar desert, rugged mountains and glaciers characterize most of the landscape, though arctic "oases" with milder climates exist in the Lake Hazen and Tanquary Fiord areas.

Parks Canada worked with university and government researchers to facilitate studies in the park in 2007. Research work focused on fish populations, wildlife habitat selection, greenhouse gas sources, contaminant remediation techniques and changing permafrost conditions. In addition, Parks Canada conducted a study to assess and monitor archaeological sites in the park and recovered a number of Thule (1000 to 1600 AD) cultural artefacts. Collectively, these studies contribute to the growing understanding of the park's water resources, arctic food-web dynamics, changing nature of vegetation and permafrost as a result of climate change, and remediation of contaminated sites in cold climates.

Quttinirpaaq National Park is cooperatively managed with a Joint Park Management Committee consisting of members from Resolute Bay and Grise Fiord. Park personnel report on research activities annually to this committee, and this information is then provided to the communities of Resolute and Grise Fiord by committee members.

Ukkusiksalik National Park Operations 2007

Principal investigator: Paula Hughson (Parks Canada)

Ukkusiksalik National Park is on the western shore of Hudson Bay and encompasses Wager Bay. This park represents the Central Tundra Natural Region in Canada's National Park system. In 2007, field teams composed of park personnel, university researchers and northern community members undertook field activities, including

- maintenance of an historical Hudson Bay Company (HBC) post
- [illegible] of numerous archaeological sites, including existing information on site locations and conditions
- identification of potential environmental hazards to visitors in various areas of the park
- surveying of wildlife along the boundary areas of the park to collect information on the wildlife populations

During the wildlife survey, a healthy herd of muskoxen was observed in the park for the first time. Updates on these activities were presented to the nearby communities of Baker Lake and Coral Harbour in 2008.

Landscape near Lake Hazen, Ellesmere Island, NU.

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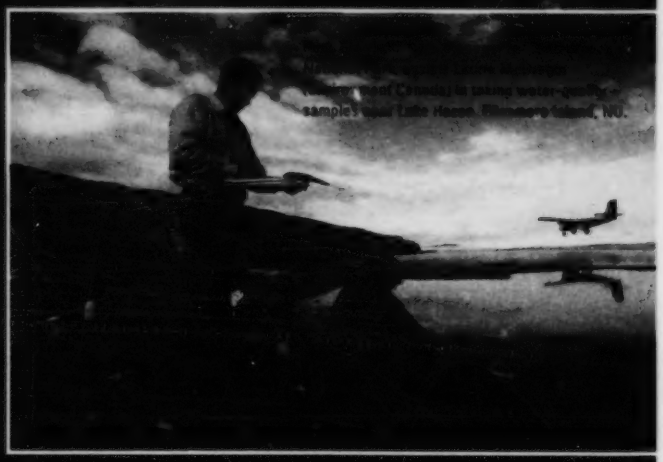

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Landscape near Lake Hazen, Ellesmere Island, NU

Glacially sculpted landscape at Tanquary Fiord in Quttinirpaaq National Park, Ellesmere Island, Nunavut.

Projects for national parks and weather station operations

Annual inspection of the automatic weather stations at Mould Bay, Isachsen, Rae Point and Stefansson Island

Locations: Mould Bay and Prince Patrick Island, N.W.T., and Isachsen, Ellef Ringnes Island and Rae Point, Melville Island, NU (based out of Resolute, NU)

Principal investigators and affiliations: Phil Barg and Rich DeVall (Meteorological Service of Canada, Environment Canada)

Sirmilik National Park operations

Location: Sirmilik National Park, Baffin Island and Bylot Island, NU (based out of Arctic Bay, NU)

Principal investigator and affiliation: Carey Elverum (Nunavut Field Unit, Parks Canada)

E-mail: carey.elverum@pc.gc.ca

Quttinirpaaq National Park operations

Location: Tanquary Fiord, Lake Hazen and Fort Conger, Ellesmere Island, and Ward Hunt Island, Quttinirpaaq National Park, NU

Principal investigator and affiliation: Ross Glenfield (Parks Canada)

E-mail: Ross.Glenfield@pc.gc.ca

Eureka Weather Station

Location: Eureka, Ellesmere Island, NU

Principal investigator and affiliation: Doug Henry (Atmospheric Monitoring Division, Environment Canada)

E-mail: doug.henry@ec.gc.ca

Ukkusiksalik National Park operations

Location: Sila Lake Lodge / Douglas Harbour, Ukkusiksalik National Park, NU

Principal investigator and affiliation: Paula Hughson (Nunavut Field Unit, Parks Canada)

E-mail: paula.hughson@pc.gc.ca

Auyuittuq National Park operations

Location: Auyuittuq National Park, Baffin Island (based out of Pangnirtung, NU)

Principal investigator and affiliation: Monty Yank (Nunavut Field Unit, Parks Canada)

E-mail: david.argument@pc.gc.ca

A helicopter on the ice of the Beaufort Sea. G. Theimann

REFLECTIONS ON THE SUPPORT OF SCIENCE PROGRAMS IN THE CANADIAN ARCTIC

The evolution of the Polar Continental Shelf Program (PCSP) over the past 50 years has seen modest beginnings in Resolute during the late 1950s through to the major logistics operation that today helps over 1100 researchers each year to meet their field work objectives.

The Arctic is a dynamic region, and through PCSP-supported research, we continue to learn more about its history, landscapes, environment and future. This research has contributed to the high profile that the Canadian Arctic has in the minds of Canadians and the international community. The most recent increase in arctic research is largely associated with International Polar Year (IPY) studies. In 2008, many IPY research projects had major field seasons, as this international research initiative winds down in 2009. Over the coming years, the results of these projects will provide a wealth of new information on Canada's North that will be of interest to scientists and all Canadians.

New results are constantly emerging from the dynamic Arctic. The record-low Arctic Ocean sea ice extent in 2007, the second-lowest sea ice extent in 2008 and the loss of major pieces of northern Ellesmere Island's ice shelves in 2008 highlight the changing arctic environment. These changes are leading to concerns and discussions regarding domestic and international shipping potential through the Arctic Archipelago, environmental protection and Canadian sovereignty in the Arctic. Major studies, such as the federal Geo-mapping for Energy and Minerals program, have been initiated to explore mineral and energy resource potential in the North. Additionally, since the start of the PCSP, Nunavut has been established as Canada's newest territory, many land claims for northern Aboriginal peoples have been settled and Traditional Knowledge has become a key element of northern science.

The Canadian Arctic is recognized internationally for its resilient people, resources and changing environment. To better understand the current issues, future risks and opportunities in the North, and to ensure environmental protection and social and economic benefits to northern residents, arctic scientists need to have effective support to conduct research and develop new information. The PCSP has been a major part of Canadian arctic research for a half-century and will continue to work with scientists, northern communities, research support agencies and other organizations to provide support for polar research efforts.

"The expertise that PCSP has acquired in moving personnel and material to remote locations throughout the High Arctic is the reason university groups, government agencies and non-governmental organizations are able to conduct the kind of high-quality research that has been occurring over the past 50 years. Without the efforts of PCSP, serious research in the Arctic would be reduced to a trickle."

- Anne Walker, Environment Canada